THE RAILROAD AND
ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

PUBLISHED MONTHLY AT No. 47 CEDAR STREET, NEW YORK.

M. N. FORNEY, ... Editor and Proprietor.
FREDERICK HOBART, ... Associate Editor.

Entered at the Post Office at New York City as Second-Class Mail Matter.

SUBSCRIPTION RATES.

Subscription, per annum, Postage prepaid.....$3 00
Subscription, per annum, Foreign Countries..... 3 50
Single copies..... 25

Remittances should be made by Express Money-Order, Draft, P. O. Money-Order or Registered Letter.

NEW YORK, NOVEMBER, 1892.

THE address made by Mr. H. G. Haines, as President at the recent meeting of the American Railroad Association, related to the changes needed in the code of train rules to accommodate them to recent changes and improvements in block signal working, and to the necessity of further changes in the system of working crowded lines under block system.

THE long-distance telephone line between New York and Chicago was formally opened October 18. At the New York end of the line a number of invited guests were present and the opening was very successful. The line had, of course, been thoroughly tested, and on this occasion the voices were distinctly heard, and conversation was carried on over the wires without difficulty.

The line used is about 1,000 miles long, and runs from New York to Pittsburgh by way of Easton, Harrisburg, Pittsburgh, Youngstown and South Bend. The poles carry two lines of No. 8 copper wire; the line is very substantially built, with heavy poles and all the latest improvements in the way of insulators and other fittings.

THE new cruiser *Brooklyn*, like the *New York*, will have four engines, two to each screw. At full speed all four will be used, but in ordinary cruising only two will be at work. These engines will be of the vertical triple-expansion type used in most of the new cruisers, and will have cylinders 32, 47 and 72 × 42 in. With 160 lbs. pressure and 130 revolutions they are expected to develop 16,000 H.P.

A peculiar feature of the *Brooklyn* will be the great height of the smoke-stacks. There will be three of these, and they will be carried to a height of 100 ft. above the grate level. Certainly they will be a very prominent feature in the general appearance of the ship.

THE law of the State of New York requires that all freight cars running in the State must be provided with automatic couplers by November 1, 1892. The Railroad Commission, however, acting on authority given it by the same law, has postponed the time for one year, until November 1, 1893. This was done on representations made by a number of the railroad companies that it would be impossible to procure the necessary material and fit up the cars by the time originally fixed.

IN the suit brought by the Interstate Commerce Commission against the Texas & Pacific Railroad, the United States Circuit Court has given an important decision, supporting the ruling of the Commission and fully recognizing its powers and duties under the law. The suit was brought for the enforcement of an order of the Commission, requiring the defendant road to desist from carrying articles of imported traffic shipped from any foreign port, upon through bills of lading, to places within the United States at lower rates than those established by the inland traffic of the road for the carriage of similar articles. The decision is, perhaps, the most important of any given under the law since its passage.

AT a meeting held in Chicago during the ceremonies of the dedication week of the Exposition, a number of gentlemen interested in the subject formed a preliminary organization of a National League for the improvement of highway roads. The object is to establish a central society to secure the co-operation and harmonious working of the different State and local societies formed for the same purpose. The new national league has abundant opportunities for usefulness, and it is to be hoped that it will be well supported.

THE latest addition to the number of States which have held road meetings is Arkansas, whose Convention was held at Little Rock, September 20. A number of papers were presented on the best plans for building and maintaining better highway roads, and the attendance was large and representative enough to secure public attention and to emphasize the public interest in the subject.

THE longest car transfer ferry in the world has been established by the Toledo, Ann Arbor & Northern Railroad, and will run across Lake Michigan between Frankfort, Mich., the western terminus of that line, and Kewaunee, Wis., the eastern terminus of the Green Bay, Winona & St. Paul Railroad. The boats have been especially built for the service and are described in another column. They are intended to meet the various difficulties of the route, including high seas and ice, and are supplied with abundant motive power. The distance run is 63 miles, or considerably longer than that made by the car-ferry across the Straits of Mackinaw.

THE decision of the Lower Court supporting the patent of Mr. Thomas A. Edison for the incandescent light has been upheld by the United States Circuit Court of Appeals, thus giving Mr. Edison and the company with which he is connected the exclusive right to make the incandescent lamp in its present form.

THE construction of steel coal barges for use on the Ohio and the Mississippi has been begun by the firm of W. H. Brown's Sons, in Pittsburgh, who propose to extend it as fast as possible. While the steel barge is much more

expensive than the wooden barges now generally used in the Pittsburgh coal traffic, it will last much longer, and it is calculated that the saving will in the end be considerable. The first barge built is 135 ft. long, 24 ft. beam, and 7 ft. 9 in. depth of hold. From the accounts received, however, it would seem that the construction lacks longitudinal strength. The barge as built is simply a steel box of the dimensions given, and it seems probable that experience will show the need of more bracing than has been considered necessary in the first one.

NOT every city is as fortunate as the town of Boisé City, in Idaho, which has a supply of natural heat ready almost at its doors. It is now proposed to heat the houses of the town by hot water from artesian wells a mile from the city, the water discharged from which comes to the surface in a boiling condition. The main pipe will be 6 in. in diameter and distribution to houses will be made by similar pipes. It is calculated that the cost of heating by this system, including a good profit on the original outlay, will be less than half the present cost with coal.

THE management of the Chicago Exposition are seriously considering the question of transportation of passengers to and from the Exhibition grounds. Many calculations have been made as to the number of passengers for which transportation must be provided. These differ, naturally, but a conservative estimate places the average daily attendance at about 200,000 persons. To carry these, there are the cable lines, the Elevated Railroad, the suburban trains of the Illinois Central and the lake steamers, and it is believed that these will be sufficient without any additional provision. Including the number which will be brought by various vehicles and will come to the ground on foot, it is estimated that somewhat over 100,000 passengers per hour can be carried to or from the grounds without dangerous crowding of trains or cars.

THE number of passengers carried by the city lines in New York during the week of the Columbus celebration exceeded anything on record in that city. Every means of transportation was worked to its fullest capacity for at least three days of the week. On Wednesday, October 12, the Elevated roads carried 1,075,000 passengers, or more than twice the usual number. The emergency was met as well as might have been expected; but the dangerous crowding and many delays showed more plainly than ever the need of additional lines, either above or below the surface.

IT is announced that work has actually been begun on the new Simplon tunnel, which will, when completed, be the longest tunnel in the world. It will extend from Brieg, in Switzerland, to Isella, in Italy, and its total length will be 12.4 miles. In this work all the machinery used will be of the most approved description, and all means will be used to facilitate the boring of the tunnel; but it is expected that from eight to nine years will be required for its construction.

THE steamer *City of Paris*, of the Inman Line, has again broken the record, having reached New York October 19 in 5 days, 14 hours and 24 minutes from Queenstown. This is 1 hour and 34 minutes less than the best time previously made, which was by the same ship, and 2 hours and 7 minutes less than the time made by the White Star steamer *Teutonic* some months ago. The total distance run on this voyage—2,782 knots—and the distances made daily were: First day, 448; second, 508; third, 503; fourth, 505; fifth, 530; sixth, 288. The average speed of the vessel for the whole trip was thus 20.7 knots an hour, and her average speed on the best day's run was 22.08 knots an hour. This exceeds any Transatlantic performance on record, and shows really an extraordinary high sustained speed.

The *City of Paris* was built in 1889. She is 580 ft. long over all and 63½ ft. beam. She has twin screws, each driven by a triple-expansion engine. The screws are three-bladed and are 20 ft. in diameter. It may be added that her average coal consumption on this trip was about 320 tons per day.

THE New York State Canal Convention met in Buffalo October 19, with a larger attendance than had been expected. A number of prominent persons were present, and the result of the meeting cannot fail to encourage those who are working for the support and improvement of the canals.

THE importance of good roads to the railroads is well urged by Colonel Pope, in a letter which is published on another page. While the road question affects all of us directly or indirectly, the railroads have, perhaps, the largest pecuniary interest directly involved, and their influence can do much to help on the agitation of the road question. The highway roads are their feeders, and the difference between easy and difficult access to a railroad station may have an important influence on its receipts.

BIG LOCOMOTIVE WHEELS.

THERE has been an endless discussion, ever since locomotives were first introduced, with reference to the size of their driving-wheels. Doubtless Stephenson and Ericsson and Hackworth at the time of the famous trial on the Liverpool & Manchester Railway, in 1829, discussed this subject as earnestly then as it is talked over now by different conditions of railroad men the world over. Practice, especially for fast passenger service, vacillates between driving-wheels of large and of small size. On another page we give an engraving of engine No. 870 of the New York Central & Hudson River Railroad, to which Mr. Buchanan has applied wheels 7 ft. ½ in. in diameter, the largest which are now used in this country. We also give engravings of the engine *Cornwall*, which is still running on the London & Northwestern, and has wheels 8 ft. 6 in. diameter, the largest which are now in use anywhere. The publication of the latter engravings in an English paper has called out some correspondence, from which it appears that the biggest driving-wheels that were ever used were employed on an engine called the *Hurricane*, built by the Messrs. Hawthorne for the Great Western Railway. This engine, it is reported, was a failure. So far as we now know there is no drawing or engraving of it extant.

From the illustration of the New York Central engine it will be seen that the boiler is so high that the chimney had to be shortened to almost dwarf proportions. This height of the boiler is due not entirely to the size of the wheels, but chiefly to the fact that the fire-box is placed

on top of the frames. Of course with large wheels the frames will be higher than they would be if the wheels were smaller, but in order to get sufficient depth to the fire-box the boiler must be placed at a considerable height above the frames. To get over the difficulty of raising the boiler and other parts of the engine when large wheels are used, a variety of expedients have been resorted to. From the engravings of the Northwestern engine *Cornwall*, on another page, it will be seen that when it was first built the boiler was placed *below* the driving-axle. This plan has been proposed by a number of inventors, but has never been successful.

In discussing this subject, Mr. D. K. Clark, in his "Railway Machinery," published in 1855, says:

> After all that had been done by Stephenson and others, to turn out an engine to suit the common gauge, which should combine the three desiderata, power, speed, and stability, it was obvious that a low center of gravity and a high driving-wheel were antagonistic elements, and they were assumed to be incompatible. The gauge could not be increased; engineers had, therefore, to find their additional power longitudinally and upward; to gain high speeds, they assumed a high wheel, and a high wheel required a high boiler. To exert power they adopted large cylinders; and to obtain power, they applied long boilers. Mr. T. R. Crampton has the merit of having solved the problem in all its fullness, of combining a low center of gravity with a large wheel and a powerful boiler. He conceived the idea of an extreme driving-axle, removing it from under the boiler, and placing it in the rear of the fire-box. This stumbling-block being removed, he lowered the boiler to just clear the axles of the carrying-wheels, removed all the machinery to the outside, enlarged the fire-box, and rendered every part accessible. Great freedom in every respect was thus gained, and unwonted facilities were afforded for properly proportioning the engine.

The first engine of this kind that was built had wheels 7 ft. diameter and cylinders 16 × 20 in. Another one, built for the London & Northwestern Railway, had wheels 8 ft. diameter and cylinders 18 × 20 in., and a third with wheels of the same diameter, but with cylinders 18 × 24 in. and 2,290 ft. of heating surface, and a total rigid wheel-base of 18½ ft. Of this engine Mr. Clark said:

> This splendid monster worked the express trains between London and Wolverton for some time, and on one occasion conveyed a train of 40 carriages within time, more than work for three ordinary engines; it was, however, laid aside on account of its excessive weight, aggravated, no doubt, by the great distance of end centers, which quickly told upon the maintenance of the permanent way.

It is said that the Norrises, who first started in business in Schenectady, built an engine there with a single pair of wheels 8 ft. in diameter, and about the year 1849, in Philadelphia, they built a number of locomotives similar to Crampton's for the Camden & Amboy Railroad. Some of these had wheels 7 ft. in diameter. The top of the fire-box was made to slope downward, and the driving-axle was placed over it. A large number of Crampton engines were built for French railroads, some of which are probably still in use.

From what we have quoted it will be seen that so eminent an authority as Mr. Clark was of the opinion that Crampton had solved the problem of high-speed engines, but the former had in his mind the bugbear of a high center of gravity, the objections to and difficulties of which recent experience has shown are purely imaginary.

Some builders made indentations for the driving-axle in the under-side of the boiler, so as to permit it to be lowered down over the axle. It was also proposed to put a transverse tube through the boiler to receive the axle, although it is not known that this plan was ever put into actual practice.

In 1849 Ross Winans, of Baltimore, built an engine called the *Carroll of Carrollton*, which was tried on the Boston & Worcester Railroad, which is now the eastern end of the Boston & Albany line. This had a single pair of wheels about 7 ft. in diameter, which were located near the middle of the engine, with a four-wheeled truck under the smoke-box and another one behind under the fire-box. To get the required adhesion of the driving-wheels, vertical steam-cylinders and pistons were placed over the driving-boxes, by which more of the weight of the engine could be thrown on the driving-wheels than they would otherwise carry. The engine was a failure and was run for only a short time, and some years after was cut up and sold for scrap.

About 1851 Seth Wilmarth, of Boston, built two engines for the Hudson River Railroad with four coupled wheels 7 ft. in diameter, with 16½ × 22 in. cylinders. Other engines with 6 ft. 6 in. wheels were also used on that line about this time. The weight of these engines was only about 22 tons (of 2,000 lbs.). They had very small boilers and fire-boxes and burned wood for fuel.

On the Pennsylvania Railroad, what were known as Class K locomotives, with 6 ft. 6 in. wheels, were built, but owing to insufficient boiler capacity were not successful in the service for which they were intended—that is, heavy and fast passenger traffic.

About 10 years ago the Baldwin Locomotive Works built an engine with a single pair of driving-wheels 6 ft. 6 in. diameter, and a wide fire-box, which was partly carried on a pair of trailing wheels under it. It was tried on several roads and was afterward bought by Mr. Eames, the inventor of the Eames brake, and was taken to England to show Englishmen what a Yankee locomotive could do. This was unfortunate for the reputation of our engines and also for Mr. Eames. The engine was not suited for English roads, and was finally sold and broken up.

Geared locomotives of various kinds have often been used, but, excepting for slow speeds, have not met with favor. An example of these was the Fontaine engine, built a dozen or more years ago. This had frictional gearing, and attracted a great deal of attention at the time it was brought out, but was ultimately submerged in the oblivion of the scrap-heap.

From this brief and imperfect review of the use of large driving-wheels in this country, it will be seen that to a great extent it is a history of failure. None of the engines with wheels over 6 ft. in diameter survived but a short time. In Europe, however, wheels 6, 7 and 8 ft. are very common, the larger sizes being employed mostly on what are called single engines—that is, engines with one pair of driving-wheels. Such wheels have been used there for a long time, apparently with great success.

The latest examples of the use of large wheels here is Mr. Buchanan's locomotive with 7 ft. 0½ in. coupled wheels, which is illustrated on another page, and which is making a very brilliant record for itself, and is proving a great success. The Pennsylvania Railroad Company have also just completed a compound locomotive with drivers of the same size, but of the performance of this we have, as yet, no report.

The reasons for the failure of locomotives with large wheels here, and their success in Europe, and finally of their triumph here, are interesting. It may be said, in the

first place, that for heavy trains a locomotive with a single pair of driving-wheels is necessarily deficient in adhesion. For that reason, too, it is unsuited for traffic involving frequent stops. It might be thought, that if the trains are light, such engines could be used even if the stops are frequent; but any one familiar with railroad practice knows that an engine is liable to slip with the lightest train, or without any train, if started suddenly. To start quickly, if a locomotive has sufficient cylinder and steam capacity it can always utilize all its adhesion, no matter how great that may be. If it is little it must start slowly; if great it can start quicker. Consequently for traffic requiring many stops much adhesion is needed. If there are few stops and the trains and grades are light, but little adhesion will suffice, and large wheels are then a great help in making fast time; but up to the present time we have had comparatively little or no traffic of that kind in this country. In the few cases in which light trains were run, with few stops, the engines employed had to be capable also of taking heavy trains, or those which stopped often. For such traffic, as before remarked, single engines are not suited, and it is because of their unadaptability to various kinds of traffic that single engines have not been used in this country.

If large coupled wheels are used, they and their connections will necessarily be heavier than they would be if they were of smaller size. To get the requisite tractive capacity, the cylinders must be increased in proportion to the wheels. This means more weight in all the connected parts. If the tractive force is great and the speed high, the consumption of steam will be in proportion. This will require great boiler capacity with a corresponding weight of that organ. Now the engines with 7 ft. coupled wheels which were used on the Hudson River road about 40 years ago weighed only about 22 tons, or 44,000 lbs. That weight could not be exceeded on the permanent way which was then used, and it was impossible to make the boiler large enough without exceeding the limits of load on the rails. If we compare this weight with that of Mr. Buchanan's new engine, which is nearly three times as heavy, it will be seen that with the latter it is possible to have the requisite cylinder and boiler capacity, and thus make an efficient all-round engine, or one which will not only haul a light train at a high rate of speed, but will, if required, and as has been shown by the performance of this engine, take a heavy train as well, at a moderate speed, and is capable of making as many stops as may be required without losing time. The era of big locomotive-wheels has arrived, and we may expect a gradual increase in their size hereafter.

THE FIRST LOCOMOTIVE IN AMERICA.

SOME of our readers may remember that in the account of the life of the late Horatio Allen, which was published in the JOURNAL of February and March, 1890, it was stated that he went to England in the winter of 1828 and 1829 and there made a contract with Messrs. Foster, Rastrick & Company, of Stourbridge, for *one* locomotive for the Delaware & Hudson Canal Company, and made another contract with the Messrs. Stephenson, of Newcastle, for *two* more locomotives. After the death of Mr. Allen, and after that account of his life was written, an examination of some old correspondence on file in the office of the Delaware & Hudson Canal Company has shown conclusively that *three* engines were built by the first-mentioned firm—among which was the well-known *Stourbridge Lion*—and *one*, the *America*, by the Messrs. Stephenson. The correspondence referred to also showed that the locomotive built by the Stephensons arrived in New York, on board the ship *Columbia*, about the middle of January, 1829. The first one of these, built by Foster, Rastrick & Company, arrived on board the *John Jay*, May 13 of the same year; the second one on the ship *Splendid* about the middle of August, and the last one on September 17 on the *John Jay*. It will thus be seen that the Stephenson machine was the first locomotive in this country, although it was not the first to run on a railroad. The singular part of its history is that it is not known what ever became of it. All trace of it has been lost as completely as though it had been cast into the sea. Being the first locomotive in this country, especial interest attaches to it, and our readers will be interested in the following data, for which we are indebted to Mr. Clement E. Stretton, of Leicester, England, who says: "I have just unearthed the official details of the engine named *America*, of which find copy enclosed."

DESCRIPTION OF LOCOMOTIVE ENGINE "AMERICA," BUILT BY R. STEPHENSON & COMPANY, FOR THE DELAWARE & HUDSON CANAL COMPANY, TO THE ORDER OF MR. HORATIO ALLEN, 1828, AND NO. 12 IN THE BOOKS OF THE MAKERS.

Diameter of boiler	4 ft. 1 in.
Length " "	9 " 6 "
Dimensions of fire-place	4 ft. × 3 ft.
Diameter of steam cylinder	9 in.
Length of stroke	2 ft. 0 "
Size of chimney	1 " 8 " (?)
" " hot-water pump	1½"
Stroke " "	2 " 0 "
Wheels (wood), diameter	4 " 0 "
Number of wheels	4
Angle of cylinder to the horizontal	33°
Size of tubes	1 ft. 7 in.
Number of fire tubes	2

Tubes were straight.

NEW PUBLICATIONS.

GEOLOGICAL SURVEY OF NEW JERSEY: ANNUAL REPORT OF THE STATE GEOLOGIST FOR 1891. Professor John C. Smock, State Geologist. State Printers, Trenton.

The Geological Survey of New Jersey, under the late Professor Cook, was noted for its thorough and excellent work and the high character of its publications; and under his successor its reputation seems to be fully maintained. The geological and geodetic surveys of the State are now nearly complete, and form a work which has been and continues to be of very great service to its people.

The present report, after some 35 pages devoted to a general account of the work done on the surveys during the year, contains a very interesting paper on the drift formations of the State and the evidences and remains of glacial action, which are abundant over a large part of its surface.

The larger part of the volume is taken up by two studies in Economic Geology. The first relates to the Oak and Pine belts of Southern New Jersey, and contains some excellent suggestions as to the best methods of utilizing them, especially with reference to the preservation of a proper and useful area of timber. The second is in relation to Water Supply and Water Power. With the growing population of the northern part of the State and its increasing concentration in towns and cities, the question of Water Supply is a very important one, and the Survey has been engaged in a careful examination of the streams and rivers, their sources of supply, flow, quality of water and other essential points. The questions of Water

Power and Drainage form an essential part of this study and have received much attention.

The report is illustrated by a number of plates and diagrams, and is accompanied by a map of the State, which is itself a most excellent specimen of work.

REPORT OF THE PROCEEDINGS OF THE TWENTY-SIXTH ANNUAL CONVENTION OF THE MASTER CAR-BUILDERS' ASSOCIATION, HELD AT SARATOGA, N. Y., JUNE 15, 16 AND 17, 1892, Chicago; published for the Association, John W. Cloud. Secretary.

The report of this Association always contains some reports and discussions of interest, and the present volume is no exception to the rule. Perhaps the most notable is the report or the Committee on Standards and the discussion following it, while the reports on Wheels and on Air Brake Instructions may also be mentioned. The report is printed and prepared with the usual care.

POOR'S DIRECTORY OF RAILWAY OFFICIALS. *Seventh Annual Number.* 1892, New York; H. V. & H. W. Poor.

This directory, the companion of *Poor's Manual*, has been the accepted standard so long that it calls for little especial remark. Some additions have been made to the book this year-notably an alphabetical index of directors of corporations. The information given about street railroad companies has been enlarged and made more satisfactory in form, and some general statements in relation to their operations are given in the preface.

Like the *Manual*, this *Directory* is indispensable to all who have dealings with railroad companies and their officers.

ANNUAL REPORT OF THE BOARD OF REGENTS OF THE SMITHSONIAN INSTITUTION. Government Printing Office, Washington.

The annual report of the Board of Regents contains the usual information concerning the workings of the Smithsonian Institution, which does not call for special comment. It contains also a number of excellent short papers giving brief accounts of scientific discovery in particular directions; these are by various authors, and most of them are interesting summaries of scientific progress. The paper on Astronomy is accompanied by a list of new publications on that subject, both in English and other languages.

GUATEMALA. Washington; published by the Bureau of the American Republics, William E. Curtis, Director.

This book—Bulletin No. 32 of the Bureau of the American Republics—is descriptive of the largest of the Central American States, a country presenting many interesting and attractive features. It is rich in natural resources of various kinds which have not been developed, chiefly because of the sparse population and the lack of labor. When this is supplied, Guatemala has great possibilities, and it may in the future become one of the wealthiest countries on this continent. Meantime it needs capital and enterprise, which the United States might supply, and perhaps will. To interest us in the country and to draw attention to its capabilities is the object of the Bureau of the American Republics in this book.

COLOMBIA. *Bulletin No. 33 of the Bureau of the American Republics.* Issued by the Bureau, W. E. Curtis, Director, Washington, D. C.

This is another of the excellent monographs on the Spanish American countries issued by the Bureau of the American Republics, in pursuance of its purpose of promoting knowledge of and intercourse with those countries. In general arrangement and design it is the same as those which have preceded it, containing a brief historical sketch, general accounts of the economic and political geography, of the political institutions, of the industries of the country, and much commercial information, including accounts of the tariff, port regulations and similar matters, and a commercial directory. Colombia is a very interesting country, with great possibilities of future development, and this number of the series is worth careful reading.

THE ENGINEER'S EPITOME: A COLLECTION OF FIGURES, FACTS AND FORMULÆ FOR ENGINEERS. By N. J. Smith. Boston, Mass.; the Mason Regulator Company. Price, 50 cents.

This is No. 3 of a series of books issued by the Mason Regulator Company, of Boston, for the information of engineers. It contains 135 pages and is of convenient size for the pocket. It is intended as a book of reference, and contains a variety of rules and other information useful for those who have charge of an engine. After some preliminary general instruction on arithmetic, etc., it has chapters on Steam; Boilers; Chimneys; Power of Engines; Condensers; Valves; Governors; Belts; Pumps; and several useful tables. The concluding pages have descriptions of the reducing and regulating valves, governors and other devices made by the Mason Company, but this advertising part is very modest in its dimensions and is well and carefully written.

The rules and formulæ are generally those which have been approved by practical use, and the book is a very handy companion for engineers, and indeed for all who have to do with stationary engines and boilers.

FIFTH ANNUAL REPORT OF THE INTERSTATE COMMERCE COMMISSION. DECEMBER 1, 1891. Government Printing Office, Washington.

The present report of the Interstate Commission gives a careful statement of the work done during the past year, and of the variety of subjects brought before it for decision. It shows the increasing volume of the work and the manner in which it has been done. It also notes the defects in the existing law, and makes several suggestions for its improvement, especially in the direction of enforcing compliance with its provisions.

Among other important questions which have engaged the time of the Commission were Uniform Classification of Freight; Use of Shippers' Cars; Through Routes and Rates; Bills of Lading; Special Rates. These have received special attention, in addition to that required by the regular work of the office.

The Convention or Conference of railroad commissioners is referred to, and some stress laid upon the advantages which may be secured from these meetings, and especially on the work done in the direction of securing the adoption of safety appliances.

The statistical work done under the direction of the Commission has heretofore been noticed from the advance sheets furnished.

AN INTRODUCTION TO GEODETIC SURVEYING. By Professor Mansfield Merriman, Ph.D. New York; John Wiley & Sons. Price, $2.

The science of Geodesy in its several branches should have an especial attraction for students, though it is, perhaps, less known and studied than it should be. Most of the works on the subject are too large for the ordinary student and engineer, whose time is fully occupied with his daily work. The author's intention in this book is perhaps best explained by himself:

In the first part of this book several lectures on the Figure of the Earth, prepared as an introduction to a course of study in Geodesy, are republished. In the second part is given a condensed presentation of the fundamental principles and rules of the Method of Least Squares, written especially for students, surveyors, and engineers who are unable to spare the time required for the perusal of the larger books on the subject. The theoretical discussions have necessarily been omitted, but

the fundamental ideas concerning adjustments, weights of observations, and probable error are fully explained, so that computations may be made intelligently and not blindly. In the third part is presented a synopsis of the methods and computations required in the field work of precise triangulation, particularly in secondary geodetic work.

Care has been taken to illustrate the rules and formulas by numerical examples, and to give problems exemplifying their applications. Thus the three parts of the book form an introduction, both theoretical and practical, to the science of Geodesy, and especially to Geodetic Surveying.

Professor Merriman has the great merit of a concise and clear style, and in all his books he has shown what many scientific writers lack, the ability to make his meaning clear to the reader, and to impart knowledge without overloading his work with explanations. The present book is no exception, and one may turn with confidence to its pages, sure that what he seeks will be told in a way that must be comprehended by any one able to read and follow a serious train of mathematical argument.

The book is illustrated by many diagrams which are necessary to make some of the explanations clear. The student of Geodesy will find it an excellent opening for his course, and the engineer need not neglect its pages.

Die Nordamerikanischen Eisenbahnen in Technischer Beziehung. The Railroads of North America in their Technical Relations. *A Report of Studies Undertaken by Direction of the Ministry of Public Works.* By A. von Borries, State Railroad Inspector, and Thomas Büte, State Railroad Director. C. W. Kreidel, Publisher, Wiesbaden, Germany.

Herr A. von Borries, who is well known by reputation as a railroad engineer in this country as well as in Germany, and Herr Thomas Büte, who is a Director of the Prussian State Railroads, last year made an official visit to this country, inspecting the methods of operation and management of some of the important lines, including the Pennsylvania, the Reading, the New York Central, the Chicago & Northwestern, and others, and they also visited some of our large manufacturing establishments. The result of this visit now appears in an elaborate report made to the Ministry of Public Works presenting the result of their observations. The *Report* makes a volume of 282 large pages, appended to which are 55 plates evidently made from drawings and photographs obtained in this country.

The scope of the report will be seen from the general titles of the different parts, which include Organization and Management; Signals; Locomotive Building; Car Building; Locomotive and Car Service; Repair Shops; Mechanical Superintendence; Brakes; Car Heating; Lubrication; Railroad Superstructure; Stations and General Conduct of Business. These commissioners from the German Government were evidently diligent in taking notes; and while their observations were, of course, chiefly made with a view to the instruction and benefit of the German railroad management, many of them might be read with profit by American managers. As to the several parts of the report, it may be said that in a general way the more technical portions in relation to construction and design have been written by Herr von Borries, and the observations as to management and the conduct of business by Herr Büte. The engravings, as before noted, have evidently been made from photographs and drawings, including a number of different types of locomotives and cars for both freight and passenger service, several yards and stations, some repair shops, and a number of tools, chiefly for wood working, that class of machinery having apparently presented more interest and novelty to the commissioners than the iron-working tools. Traffic as well as technical management received their attention, and much is said in the report in relation to the handling of both freight and passenger business, rates, and even the management of the sleeping, parlor and dining car service.

The report, in fact, is a good specimen of the practical application of German thoroughness of observation and method. It may be added that the brief reading which has thus far been possible seems to show that American methods were in general favorably regarded by the writers, although some occasion has been found for criticism.

Mechanical Drawing. *Progressive Exercises and Practical Hints.* By Charles W. MacCord, Professor of Mechanical Drawing in the Stevens Institute of Technology, Hoboken, N. J. New York; John Wiley & Co.

This book consists of two parts: the first, which is new, on Mechanical Drawing, and the last, Practical Hints for Draftsmen, which was first published in 1887; the two being now issued in one volume. The first chapter gives elementary exercises in drawing, straight lines and circles. It contains many hints for the young draftsman which are excellent in their way; but there seems to be a lack of practical illustrations and applications of those principles. It is true that the Author says that those for whom he is writing "are presumed to have gained, from other sources, an acquaintance with such geometrical principles as may be made use of in the course of the work," but even a student well up in geometry who should take this first chapter for his guide in learning mechanical drawing would, it is thought, be a good deal puzzled to know how to proceed. In beginning to learn this art the first thing is to get the required materials and instruments, which is usually a matter of great interest and importance to the beginner, and generally in doing this he makes some sad mistakes, and wastes money which he cannot easily spare. In the book before us the description of the drawing instruments is given in the last chapter instead of the first. If the student has wit enough to begin his course of study by reading the end of the book first, and has provided himself with the requisite tools, and should take the first chapter as his guide, he would probably be sadly puzzled to know just what to do with them, even though he was acquainted with geometrical principles. A variety of directions are given with reference to penciling, inking, laying off measurements, thickness and junction of lines, etc., all excellent in their way. The first specific instruction to the student how to draw anything is that on page 12, on which he is told how to inscribe three circles in another circle all tangent to each other and the same number in a triangle—rather difficult tasks for a beginner who has no knowledge or experience in using drawing instruments. The succeeding problems are six and seven circles inscribed in a triangle and in a circle, complicated star patterns inscribed in a circle, interlaced work, circles tangent and eccentric to each other—"confined tangencies," ovals, etc. The directions to the learner how to proceed in doing this work are brief and quite inadequate for one who is without any knowledge of the subject. Doubtless under the eye of a teacher he would get along without much difficulty; but this ought not to be needed in a course of "Progressive Exercises."

The title of the second chapter is Exercises in the Drawing of Non-circular Curves. The progress in this, as in the first one, is at times too steep. To ask a beginner, in his second lesson, to draw "epitrochoid, Archimedian spiral, and logarithmic spiral" curves is establishing a grade for the learner too steep for the adhesion of his comprehension.

Chapters III and IV are on the principles of projection, and they are excellent in their way, but are introduced too early in the course. If some of the practical examples in the first part of the second portion of the book had been introduced before the principles of projection were explained, it would have made the ascent for the learner much easier.

Chapter V is on the Helix and its Application in the Drawing of Screws, a subject which has very little practical value

to a draftsman, and which might with advantage have been relegated to a later position. The sixth chapter is on Intersections and Development of Surfaces, which is very clear and useful. The seventh is on Isometrical Drawing, Cavalier Projection, and Pseudo-Perspective. The eighth and last chapter is on the Spur-wheel and the Bevel-wheel in Inclined Positions, Construction of the Close-Fitting Worm and Wheel, Construction of the Screw-Propeller, Standard Sectioning, etc.

The book is full of valuable hints and suggestions made by an accomplished draftsman of extended experience who knows his subject thoroughly, and therefore they have a corresponding value. The book is admirably printed and illustrated, but is badly arranged. Much that is in the first part should be last, and *vice versa*. Its progress should be by easier steps, and it would be much improved by simply arranging the chapters in different order. The old part has been spliced on to the new, whereas it ought to have been incorporated with it.

CURRENT READING.

In the November number of HARPER'S MAGAZINE the New Growth of St. Louis is the subject of a striking article. Another paper treats of a now almost forgotten historical episode, the struggle for the possession of Oregon; while a third treats of the designing and supervision—the architects' work—on the buildings of the Columbian Exposition. The number is particularly strong in fiction and in its illustration.

In its discussion of graver topics the ARENA does not entirely neglect amusement, and in its October number gave an appreciative and excellently illustrated article on Sothern, who is undoubtedly one of our best comedy actors. This will be followed at intervals by similar papers. This mixture of entertainment is good; but the great strength of this magazine continues to be in its absolutely free and fearless discussion. No other periodical approaches it in this respect, and it has acquired a position for itself which gives it a wide constituency among thinking people. No one who wants to know the best of current thought and discussion on the problems of modern life can neglect it.

Some of the best of current articles from the English reviews are given in the ECLECTIC MAGAZINE for October, and even a greater variety than usual is there presented.

Chicago's Part in the World's Fair; the Sponges of the Florida Reef; French Art, and Racing in Australia, are among the subjects treated in SCRIBNER'S MAGAZINE for November. Several very interesting literary papers are also among its contents, including an account of the Journal kept by Victor Hugo during his long exile from France.

In the number of HARPER'S WEEKLY for October 5 there are several illustrations of the buildings at the Columbian Exposition. Sir C. W. Dilke has an excellent article on London, and there is an illustrated account of the Columbus celebration at Genoa.

In the September number of MINERALS there are articles on Aluminum; Bismuth Mining in Australia; Indian Diamond Fields; Mining Exhibits at the World's Fair, and a number of others of interest.

Corsica; the Nile and its Floods; the Androscoggin Valley; the Arctic; Irrigation in Ceylon; Columbus and his Times, are among the subjects treated in GOLDTHWAITE'S GEOGRAPHICAL MAGAZINE for September. This does not complete the list, as there are also a number of shorter articles on different topics.

The latest number of GOOD ROADS has articles on the Cost of Bad Roads, by Professor Ira O. Baker; on Ways and Means; on National Aid to Road-Building; on Sidewalk Specifications; and the conclusion of Editor Potter's papers on Dirt Roads and Gravel Roads. It is a good number and ought to be read everywhere.

In the October number of the ENGINEERING MAGAZINE there are articles on the Industrial Development of the South; the Regulation of the Professions; Bridge Building in America; Industrial Decadence in Germany; the Copper Region of Michigan; Guarding against Cholera; Measurement of Electricity; the Phosphate Industry of Florida; Interior Fireproof Construction; Reciprocity with Canada; Colonel E. C. Smeed and his Work; and the usual special editorial departments, the latter being very good of their kind.

The last number of the PROCEEDINGS of the United States Naval Institute is given up entirely to the publication of six lectures on First Aid to the Injured and Transportation of the Wounded, by Dr. Henry G. Beyer. These lectures were recently delivered to the naval cadets at Annapolis.

The military article in OUTING for October is on the New Jersey National Guard, and is by Lieutenant W. H. C. Bowen, U. S. A. A number of articles on shooting, athletics, the bicycle and travel, with some very good illustrations, make a very attractive number.

In the POPULAR SCIENCE MONTHLY for November Dr. Wesley Mills treats of the Natural or Scientific Method in Education. Among the other articles are papers on Economical Trees, by F. L. Sargent; on the Mixed Race of India, by Sara J. Duncan; on the Scientific Societies of Italy, by Dr. W. J. Cahall; on Problems of Comparative Psychology, by Dr. Jastrow, and a number of shorter ones of interest.

BOOKS RECEIVED.

Selected Papers of the Institution of Civil Engineers. London, England; published by the Institution.

A Ready Reference for Engineers and Steam Users. By James B. Stanwood, M.E. Cincinnati, O.; Houston, Stanwood & Gamble. Price, 25 cents.

Report on the Internal Commerce of the United States for the Year 1891. *Part II. of Commerce and Navigation: The Commerce of the Great Lakes, the Mississippi River and its Tributaries.* S. G. Brock, Chief of the Bureau of Statistics, Treasury Department. Washington, D. C.; Government Printing Office.

Massachusetts Institute of Technology: Department of Engineering Prospectus for 1892-93. Boston; published by the Institute.

Chairman's Report of the Operations of the Melbourne Tramways Trust from October 26, 1888, *to August* 19, 1892. Melbourne, Victoria; printed for the Tramways Trust.

Journal of the New England Water Works Association: September, 1892. New London, Conn.; published for the Association.

TRADE CATALOGUES.

Partial List of Purchasers of Reynolds' Corliss Engines. The Edward P. Allis Company (Reliance Works), Milwaukee, Wis.

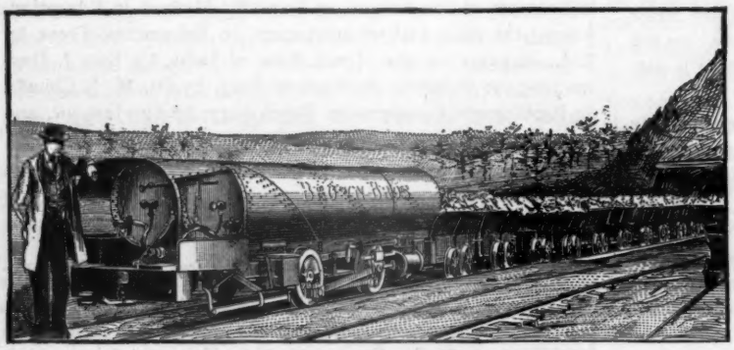
This pamphlet contains a long list of engines of all sizes and built for all sorts of purposes. It shows that the engines of the Allis Company are found in all parts of the country, East as well as West. The largest engines on the list are a compound condensing pumping engine for the Chapin Mining Company at Iron Mountain, Mich., which has cylinders 50 and 100 × 120 in., and a triple-expansion pumping engine for Omaha, which has cylinders 40, 70 and 104 × 60 in. There

are a large number of compound and triple-expansion engines in the list, and at least one quadruple-expansion, which has cylinders 24, 36, 52½ and 64½ × 72 in., and was built for the Warren Manufacturing Company at Warren, R. I.

Light Locomotives. H. K. Porter & Company, Pittsburgh, Pa. Seventh Edition, 1892.

The use of small locomotives, not only for ordinary railroad purposes, but also for moving material in furnaces and factories, for mining purposes, for contractors on earthwork, for street railroads, and in many other places, has been gradually extending in this country, and they are now found at work in many places where the advantages of steam over animal power have been realized.

While all locomotive builders are occasionally called upon to supply light locomotives, there is at least one establishment which devotes its time entirely to the building of this class of engines. The shops of H. K. Porter & Company, in Pittsburgh, have for a number of years been engaged in this work, and their long experience naturally gives them many advantages. The latest edition of the catalogue issued by the firm shows a great variety of types and classes of engines for general purposes and for special varieties of work. How great this variety is can hardly be appreciated without an inspection of the catalogue itself.



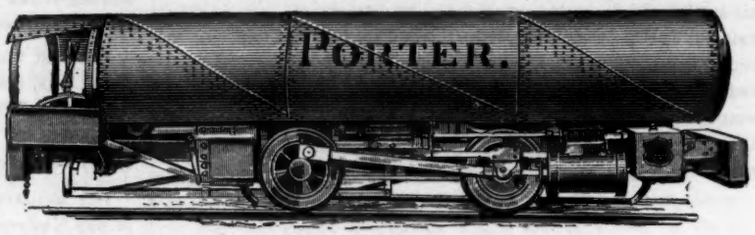
COMPRESSED AIR MINING LOCOMOTIVE.

Among the different kinds of engines illustrated are locomotives for passenger and freight service on narrow-gauge and other light railroads; motors for street railroad service; engines for shifting and yard work on railroads and in factory yards; for coke ovens and blast furnaces; for logging railroads; for contractors' temporary lines; for plantation lines; for moving blooms and ingots in steel works and rolling mills; and for a number of other purposes, including underground work in mines.

As an illustration of the class of work engines of this kind may be called upon to do, the cut given herewith shows a six-wheel engine on a logging railroad, on the Pacific Coast, with a train of redwood logs. In this case the road-bed is comparatively good, consisting of steel rails laid on stringers which are held together by cross-ties. In many cases the road-bed of this class of lines is of the roughest description, and the engine is called upon to do heavy work under very unfavorable conditions. For this the builder must be prepared and make allowance in his designs.

An engine of the class shown, with 9 × 14-in. cylinders, works over short grades as high as 212 ft. to the mile, frequently hauling 10 cars weighing 62 tons in all.

A recent addition to the catalogue of this firm is compressed-air locomotives for mining purposes, two of which are shown herewith. It will be seen that the running-gear is similar to that of a steam locomotive, but the boiler is replaced by the air reservoir. This may be a single cylinder, as shown in the first illustration, or twin cylinders, as in the second, according to the dimensions permitted by the size of the mine galleries. They can frequently be used in mines where from local causes a steam locomotive could not. In these engines the air reservoir is made to carry pressures as high as 500 lbs.



COMPRESSED AIR MINING LOCOMOTIVE.

It may be added that while the heaviest engine shown in this catalogue has 14 × 24-in. cylinders and corresponding weight and general dimensions, there are locomotives included, for plantation and mill purposes, which have 5 × 10-in. cylinders, 22-in. driving-wheels, and weigh only 8,000 lbs. in working order. Such engines are doing good and effective work, one of them being on record as having hauled a train weighing 54 tons, without difficulty.

This catalogue is an interesting study, as it shows a great variety of designs for special purposes, in a field where there is probably much more diversity of requirements than is found in locomotives of the sizes used in ordinary traffic.

LOGGING LOCOMOTIVE, WITH TRAIN OF REDWOOD LOGS.

The Butler Drawbar Attachment Company's Illustrated Catalogue and Price-list. Cleveland, O.

This pamphlet contains a very handsomely printed and illustrated description of the various devices made by the Butler Drawbar Attachment Company. The use of these is rapidly extending, a fact which needs no explanation after looking over this catalogue, since the usefulness of the attachments is at once apparent from the descriptions. Every one who is interested in building and running cars ought to see this pamphlet.

Indicators, Planimeters, Pantographs, Speed Counters. The Thomson Hydraulic Company, Temple Court, New York.

This company has recently purchased the business and plant of the Engineers' Instrument Company of New York, and will continue the manufacture of the instruments named above, as an adjunct to its own chief business, which is the making of water-meters. The catalogue shows the instruments made, with some notes on their use.

Catalogue and Price-list of the Sweetland Chuck, the Standard Chuck and the Porter Belt-clamp. The Hoggson & Pettis Manufacturing Company, New Haven, Conn.

This pamphlet contains illustrated descriptions of the devices mentioned and of several others which are manufactured by the Hoggson & Pettis Company. Most of them are already well known and approved by continued use in machine work. The Sweetland chuck especially has a wide range of service and is in use in many places.

The Reynolds-Corliss Engine. Catalogue of the E. P. Allis Company, Milwaukee, Wis. New Edition, 1892. *Illustrated.*

SOME CURRENT NOTES.

AT the naval parade in the New York Columbus celebration the representation of war-ships was not very large, though the ships present were good of their kind. Italy sent the cruiser *Giovanni Bausan;* Spain the cruiser *Infanta Isabel*, and France the cruiser *Aréthuse* and the dispatch-boat *Hussard*. None of these were ships of the largest class. Our own Navy was represented by the cruisers *Philadelphia* and *Atlanta*, the monitor *Miantonomoh*, the dynamite cruiser *Vesuvius*, the dispatch-boat *Dolphin*, and the torpedo-boat *Cushing*.

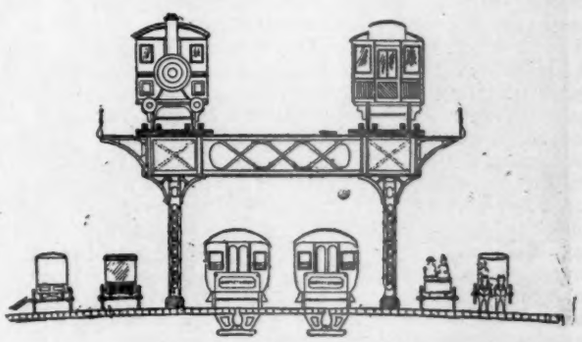
A VERY curious inquiry undertaken by some French scientists seems to show a certain relation between railroads and the average height of the people. From the statistics collected in connection with the conscription, to which all young men in France are subject, it appears that in certain communes and departments there has been a notable increase in the average height of the men in the last 30 years, or since the building of railroads in those departments. This is attributed to the fact that the railroads have offered better paying work to the people, both directly and indirectly, by the introduction of manufactures; this has improved the condition of the people, who are now better housed and fed than formerly, and consequently grow to a greater height. The reasoning is carefully worked out, and the connection seems to be well established.

THE latest canal project in Europe is for a waterway to connect the Danube and the Oder. The proposed canal is to leave the Danube near Vienna, and to pass through Lower Austria, Moravia and Silesia to Oderburg. It would furnish cheap transportation for coal to Vienna, which is much needed by that city. The project includes branches through Bohemia to the Upper Elbe, and through Galicia to the Vistula, opening up an extensive system of navigation.

FROM a paper recently presented before the Statistical Society in Paris, it appears that there are in use in France 78,600 steam-engines, having a total of 5,360,000 H.P. From 1880–90 the increase amounted to 647,000 H.P., and since 1890 it has been 184,000 H.P. This statement applies to stationary engines only, and does not include the locomotives in use on the French railroads. In recent years the increase has been rapid, owing to the increase of manufactures and to the extension of railroads, making fuel cheaper and more easily procured than formerly.

THERE are reports that the Russian Trans-Caspian Railroad is to be extended beyond its present terminus, and that several branches are to be built. The growing commercial importance of the line may have something to do with this, but the ruling factor will be political. The Trans-Caspian is a great element in the Russian political power in Central Asia, and any new building will be done with a direct view to the extension of that power—and perhaps also to the advance on India which is sure to come sooner or later.

THE plans of the Quaker City Elevated Railroad Company for its line through Market Street in Philadelphia have been submitted. From the accompanying sketch,



PROPOSED ELEVATED RAILROAD IN PHILADELPHIA.

which shows a cross-section, it will be seen that the structure will bear a considerable resemblance to that of the Sixth Avenue line in New York. It will be somewhat heavier, but of the same general type. The motive power will be furnished by steam locomotives burning anthracite coal.

THE Altoona shops of the Pennsylvania Railroad have just turned out a heavy compound engine which will be tested on that road with a view to determining, if possible, what advantage may be secured by the double expansion. This engine—No. 1515—weighs 72½ tons; it is of the two-cylinder type with cylinders 19½ in. and 31 in. × 28 in. The low-pressure cylinder is, we believe, the largest ever made for a locomotive. The boiler will carry a working pressure of 200 lbs. The ratio of the cylinders is 1 : 2.53. The driving-wheels are the largest ever made by this company, being 7 ft. in diameter. This engine will be put in service on the New York Division, on the fast trains between New York and Philadelphia.

THE Lehigh Valley Railroad will soon put into service 10 consolidation engines of the Vauclain four-cylinder type, which will have a thorough trial in heavy freight work. These engines are now being built by the Baldwin Locomotive Works; they have cylinders 14 in. and 24 in. × 26 in., and driving-wheels 55½ in. in diameter. The crank-pins are of steel, and will all be bored and oil-tempered, as described in the JOURNAL some time ago.

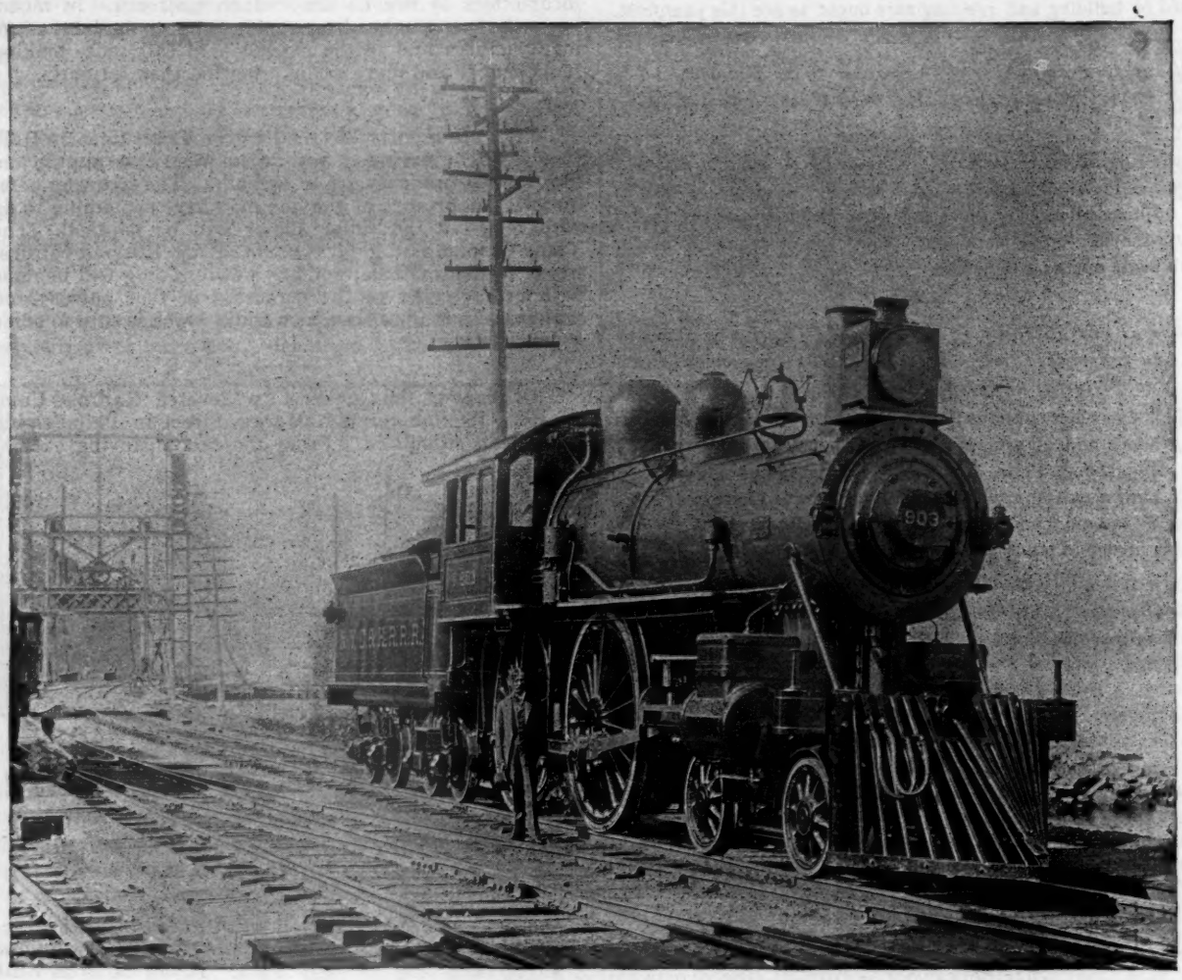
ON October 1 the tables of the *American Manufacturer* show that there were 242 furnaces in blast, having a total weekly capacity of 161,558 tons of pig iron. This is a slight increase over the September report, the producing capacity having gained about 3 per cent. during the month. It is a considerable decrease—11 per cent.—from October of last year, however; but the rate of production was then extraordinary, many of the large bituminous and coke furnaces having just blown in after a long stop. The production this year has been much steadier and more uniform than in 1891.

AT the new ship-yard of the Maryland Steel Company, in Baltimore, it is proposed to do away with launches by building ships in dry-docks, which can be flooded when a vessel is ready. This plan has been suggested before and occasionally used—notably with some of the large English battle-ships—but has never, we believe, been made a regular feature of a yard.

THE report of the Railroad Commission of New South Wales for the year ending June 30 last shows that the Colony has 2,266 miles of railroad in operation. The general depression of business affected the roads, but their total earnings were about $15,536,000 gross and $5,965,000 net. The surplus remaining was sufficient to pay 3.58 per cent. on the capital invested in the construction of the roads. Like all government systems, the lines include some which have an exceedingly light traffic and which have to be carried by the stronger main lines; but the result seems not unfavorable, especially when it is considered that very few countries have so small a population per mile of road as New South Wales.

A NEW building in Chicago is to have its outer coat or front entirely of aluminum bronze and glass. The effect will certainly be striking and novel.

THE total tonnage of freight passing through the Sault Ste. Marie Canal in September was 1,661,303, of which 1,233,403 tons were eastward and 427,900 tons westward bound. The heaviest items of freight were 812,153 tons of iron ore; 363,673 tons of coal; 3,993,318 bushels of wheat, and 755,802 barrels of flour. The water route still controls a large share of the grain traffic.



LOCOMOTIVE NO. 903, NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

AT the September meeting of the Western Railroad Club Mr. A. M. Waitt, of the Lake Shore road, treated the subject of Steam Heating for Cars in a carefully prepared paper. His conclusions are strongly in favor of the direct system of heating for passenger cars, while he admits the advantages of the indirect system for sleeping cars. An essential point in any system, he thinks, is the provision of means for supplying steam to standing cars at terminal stations and important junction points.

AT the September meeting of the New York Railroad Club Mr. Hugh Baines presented an interesting paper on the relation of rolling stock and track, based on experi-

ence with a number of special stock cars in use between New York and Chicago. His argument is in favor of the longest wheel-base possible for a truck and for as solid a frame as can be secured. He says also that lowering the side-bearings so as to throw most of the weight on the center-bearing was followed by a rapid increase in flange friction, and from this he draws the obvious conclusion.

THE second paper at the New York Club meeting was read by Mr. F. A. Stinard, and was on Boiler Scale and Purification of Water. There are very few who do not recognize the importance of this subject, but unfortunately there is little agreement on the best means of improving the quality of water. The plan described in the paper has the merit of simplicity, while its efficacy has been tested under very trying circumstances.

A NEW YORK CENTRAL FAST LOCOMOTIVE.

THE illustration given herewith is from a photograph of Engine No. 903, of the New York Central & Hudson River Railroad, which claims the largest driving-wheels in America.

This engine was built by the Schenectady Locomotive Works, and was originally of the standard pattern used on this road for heavy and fast passenger service. It has recently been rebuilt in the company's shops at West Albany, where it received the larger driving-wheels and other alterations made necessary by their use.

The boiler is of large size and has 1,821.5 sq. ft. heating surface. The usual working pressure is 180 lbs. The cylinders are 19 × 24 in. and the driving-wheels are 7 ft. 0½ in. in diameter. Their size and the great height of the engine are shown by contrast in the photograph.

The total weight of this engine is 121,000 lbs., of which 81,000 lbs. are carried on the drivers and 40,000 lbs. on the truck.

The tender weighs in service 80,000 lbs.; it carries 3,587 galls. of water and 7 tons of coal. It is provided with a scoop for taking up water from the track tanks without stopping. The total weight of engine and tender ready for service is thus 201,000 lbs.

This engine is employed in running the "Empire State Express" between New York and Albany, the schedule time of the train being 52 miles an hour. From some indicator diagrams taken while the engine was running at the rate of 76 miles an hour, it appears that at that speed there was 1,120 H.P. developed. The usual train is four cars.

While this engine has the largest drivers now in use in this country, they are not the largest that have been built here. Reference has been made in our columns* to some old engines on the Camden & Amboy Railroad which had a single pair of driving-wheels 7 ft. 6 in. in diameter. In fact there was, some 35 or 40 years ago, a tendency to use larger drivers than have since been common, although 6 ft. was seldom exceeded. The engines referred to, however, were very much lighter than our present types, and could not have handled the heavy cars and trains now in use.

An engine of the same class, but having driving-wheels 6 ft. 6 in. in diameter, made a somewhat unusual run with a special train on October 4. The engine—No. 870—and tender weigh 201,000 lbs., and the weight of the train was 592,700 lbs., making a total of 793,700 lbs. The train consisted of five ordinary passenger cars and five sleeping cars. The run from Albany to Poughkeepsie was made in 1 hour 17 minutes, the average rate of speed being 54 miles an hour. The wind at the time was heavy, blowing from the west. The steam pressure during the run was kept at 160 to 170 lbs. The speed maintained was certainly remarkable, considering the weight of the train.

* See the RAILROAD AND ENGINEERING JOURNAL for January, 1892, pages 10 and 11.

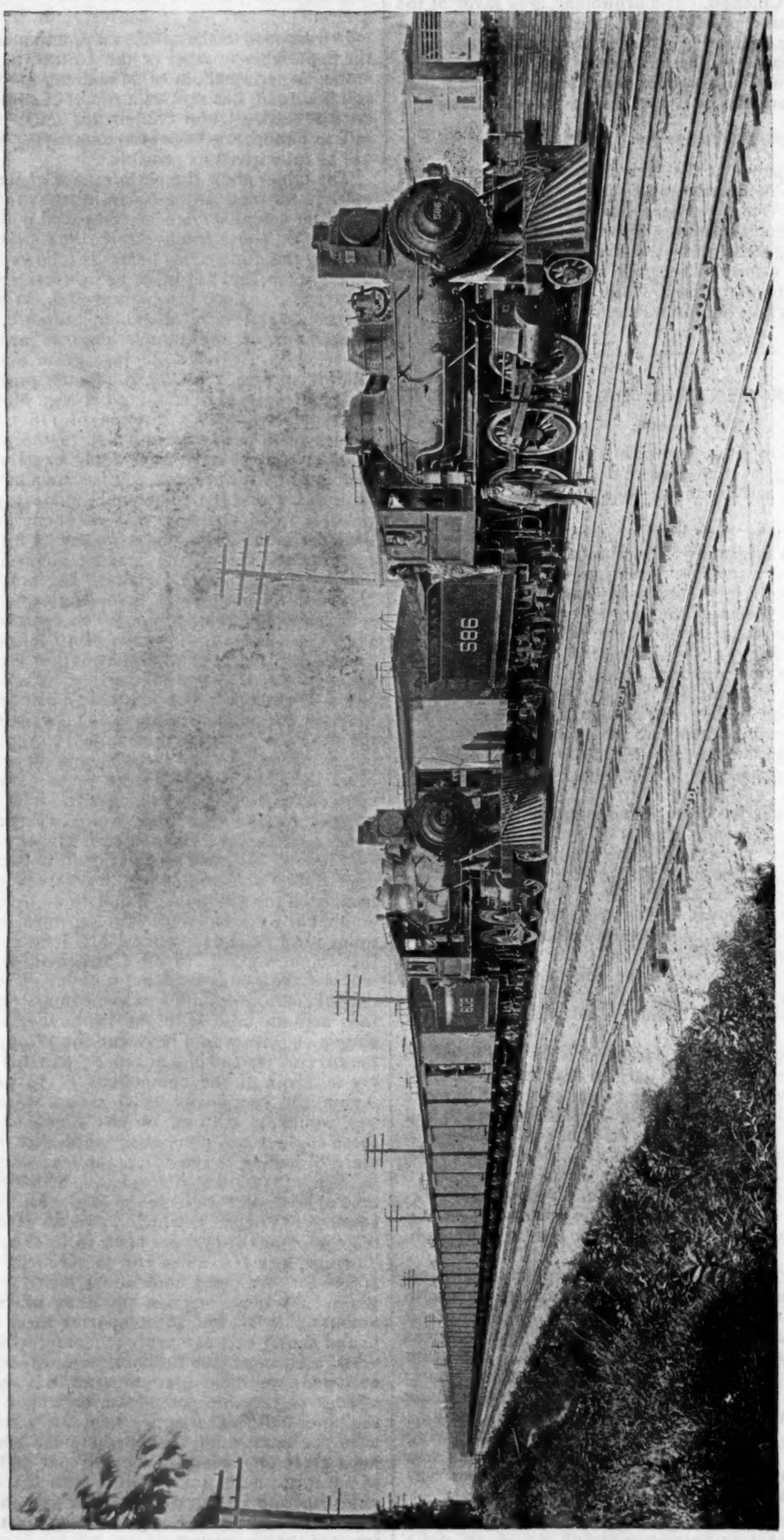
SOME COMPOUND LOCOMOTIVE TESTS.

IN response to the article on Compound Locomotives in the September number of the JOURNAL, Mr. F. W. Johnstone, Superintendent of Machinery of the Mexican Central Railroad, has sent us a report of some tests conducted on his road. Unfortunately his letter was received too late to publish the tables accompanying it, but the results are as fully given as possible.

The tables show the performance of six compound locomotives for the months—November 1, 1891, to August 31, 1892—in actual service, as compared with six simple locomotives of equal tractive force and practically the same weight, the dimensions being as follows: Compound, cylinders, 14 in. and 24½ in. × 24 in.; drivers, 56 in.; weight on drivers, 104,000 lbs.; grate area, 27.3 sq. ft.; heating surface, 2,004 sq. ft.; boiler pressure, 175 lbs. The dimensions of the simple engines are: Cylinders, 20 in. × 24 in.; drivers, 48 in.; grate area, 30.4 sq. ft.; heating surface, 1,801 sq, ft.; boiler pressure, 150 lbs.

These engines are running between Mexico City and San Juan del Rio, over a division of 118 miles, with ruling grades of 1½ per cent., or 80 ft. to the mile. These two types of engines have been doing exactly the same work, running first in, first out. It is shown by the statement in table No. 1 that the compounds made 1,378 trips out of a possible 1,800, showing that each engine lost but seven days per month, which was necessary for the purposes of washing the boiler and making slight running repairs. The average mileage for these engines for every day included in the ten months is 102½ miles, which is very good service for a freight engine. The run over the division is 118 miles, and an allowance of 16 miles for switching is given each freight engine, the engines averaging 134 miles for every day they were in service. From this table—No. 1—we see that the compounds did a little more work in running 184,591 miles, hauling 2,113,607 cars one mile, than the simple engines did in running 191,549 miles—2,077,001 loaded car-miles—and in units of work per mile run it appears the simple engines were not as heavily loaded as the compounds, the figures being 7.79 for the latter and 7.43 for the former. In table No. 2 we see that the compounds effected an economy of 22 per cent. in the consumption of fuel, and 18.7 per cent. in total cost of operating; but as the simple engines were not loaded quite as heavily as the compounds, and to do practically the same amount of work had to run 191,549 miles instead of 184,591 miles run by the compounds, Mr. Johnstone assumes that the simple engines, if loaded as heavily as the compounds, would have done the same amount of work by running only 184,591 miles, and used no more coal per mile than they actually used with the trains they hauled; then the simple engines would have run the 184,591 miles on 8,000 tons of coal instead of 8,202 tons; and this leaves an economy in favor of the compounds of 19 per cent. in fuel. Again, the cost in wages of crews, watching and cleaning, would be reduced on the simple engines by $652 if these engines had done their work with 184,591 miles instead of having to run 191,549 miles; add to this the reduction of $3,040.95 in coal bill, by deducting the 202.73 tons of coal, and we have the total cost of simple engines equal to $146,996.65, which leaves an economy in favor of the compound of 15.8 per cent. in total cost of operating. The cost per 100 miles run is given in table No. 3 as $68.76 for the compound and $78.66 for the simple engines. As these engines ran more miles to do the same amount of work, and in comparing these results the compound shows 14.4 per cent. economy, while if we take the work performed per dollar of total expense as it actually occurred, we have 9.4 units for the simple engine as against 11.3 for the compound, or 20 per cent. in favor of the latter. If, however, we take the allowances referred to in the paragraph above, where the simple engine has been given credit for 202 tons of coal and $652 in wages, to put it upon the same footing with the compound as to miles run and weight of trains, we find the units of work per dollar of expense, 9.7 and 11.3, or 16.5 per cent. in favor of the compound.

The statements given above by Mr. Johnstone certainly



RECENT BRAKE TRIALS ON THE NEW YORK CENTRAL & HUDSON RIVER RAILROAD.
READY FOR THE START.

show a fair trial in actual service, extending over a considerable period of time. It may be added that the Mexican Central is especially concerned in this question, as the very high cost of fuel makes a saving in its consumption show materially in the expenses.

[The above report of the performance of simple and compound locomotives is interesting; but probably most of our readers would rather draw conclusions from what the locomotives actually have done than from any hypotheses of what, under other circumstances, they might do. Now, the figures submitted by Mr. Johnstone show that the simple engines burned 7.9 lbs. of coal per car per mile, and the compounds 6.35, a saving by the latter of very nearly 20 per cent. It is inferred, though, that the simple engines were not loaded up to their full capacity, which would tell against them. Furthermore, the compounds had about 11⅛ per cent. more heating surface than the simple engines, and 4 per cent. more weight on the driving-wheels. The difference in the weights on the trucks of the two engines is not given. It is not clear, either, whether the figures given were ascertained by weighing the engines, or are merely approximations. The evenness of the figures suggests approximation merely, which is apt not to be entirely reliable.

The advocates of the compound system generally claim the privilege of increasing the weight of the front ends of their locomotives, and argue that any addition to the weight on the truck is a matter of no importance. But sauce for the goose is, proverbially, sauce for the gander. If an addition to the weight on the truck of a compound locomotive is permitted, the same privilege should also be allowed to the simple engine. As a matter of fact, important consequences may result by increasing the weight on the truck of a simple engine, as a longer and more economical boiler may thus be used. The compound system involves the use of larger cylinders, steam-pipes, and other parts, with a consequent increase in weight. To the extent to which the weight of these parts is increased, the compound system is a disadvantage, and the advocates of simple engines may justly claim the privilege of utilizing an equal addition to the weight of their engines. To make a comparison of simple and compound locomotives fair, the *total weight* of each should be the same. Was this the case with the engines tested by Mr. Johnstone? His figures show that the compounds had 4,000 lbs. more weight on the driving-wheels than the simple engines had, but do not show the difference on the trucks. Furthermore, what were the relative ages of the two classes of engines? It will be seen that the cost of repairs of the compounds was greater than for the simple machines. Now, if the compounds were new and the simple engines were old, this difference is significant.

It would throw much needed light on this subject if some railroad company should give an order for, say, a ten-wheeled compound locomotive to a firm or company who are advocates of that class of engine, with specifications somewhat as follows: Driving-wheels, 56 in. in diameter; maximum weight on one driving-wheel, 15,000 lbs.; on truck, 30,000 lbs.; total wheel-base, 23 ft. 6 in. Then give another order to a firm which does not advocate the use of the compound system for a simple locomotive, to be the same specifications, allowing both designers of the engines to proportion the parts and dispose of the weights as they might choose. Then test the engines in service, as Mr. Johnstone has tested his, keeping a careful account of loads hauled and fuel burned. The designer of the simple engine, if he understood his business, would have the largest boiler without exceeding the specified weight, and to that extent would have an advantage, because the maxim may be implicitly believed that "Within the limits of weight and space to which a locomotive is necessarily confined, the boiler cannot be too big."

The saving of 20 per cent., which Mr. Johnstone's tests have shown, is of very great importance, especially on a road on which coal costs $15 a ton, as it does on his line. If this economy can be gained by the compound system of locomotives if compared with simple engines of like weight and under fair conditions, and without too great an increase in cost of repairs or loss of service, the compound system must certainly be adopted, especially where coal is dear. The question of prime importance, which railroad men are asking with much eagerness, is whether such an economy is realized when all the conditions are fair for both systems.—EDITOR RAILROAD AND ENGINEERING JOURNAL.]

RECENT BRAKE TESTS.

THE illustration given herewith is from an excellent photograph of two freight trains prepared for a test of the brakes made by the Westinghouse and the New York Air Brake Companies. The test was made by Mr. P. H. Dudley on the line of the New York Central & Hudson River Railroad, and for the information of that company.

The trains, as will be seen from the photograph, consisted each of a ten-wheel locomotive drawing a train of freight cars, one train being equipped with the Westinghouse and one with the New York Company's brake. Trials were made with both brakes, and also with trains made up of cars equipped with the two brakes, so as to determine whether there would be any difficulty in using them together in ordinary service.

Mr. Dudley's report, we understand, has not yet been completed and submitted to the company, but it will be seen from the statement given in another column that the results were satisfactory for both parties, and that in the mixed tests especially no practical difference was found in the working of the two brakes.

The photograph is given here as an excellent view of the two competitors ready for the trial.

GOOD ROADS AND THE RAILROADS.

THE following memorial or circular was recently sent by Colonel Albert A. Pope to the officers of a number of the leading railroads of the country. It may be added that already some very encouraging responses have been received, and that several important roads take much interest in the subject of better roads as feeders to their own traffic:

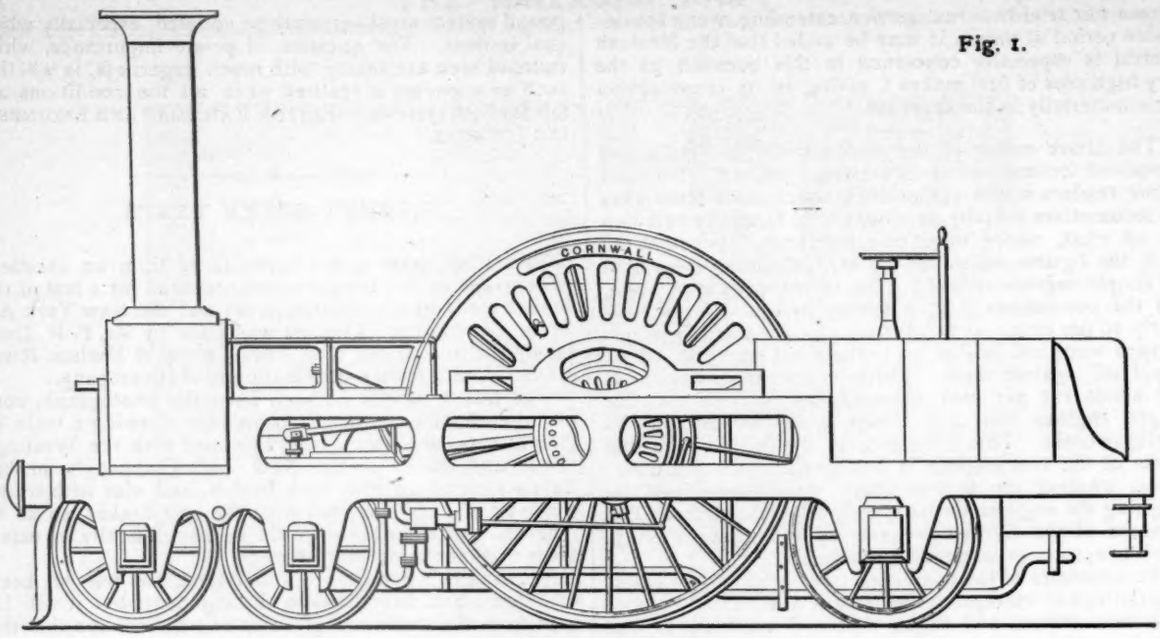
Permit me to urge upon your attention the great importance of good roads as feeders to railroads. Throughout the United States the condition of the common country roads is the index to the prosperity of railroads. When highways are impassable, freight and passenger earnings are necessarily diminished and the price of railroad securities lowered; when the roads are in good condition, merchandise is accumulated at the depots, and in moving it trains are delayed and accidents increased. A uniform good condition of roads would enable railroads to handle freights more expeditiously and advantageously.

Good roads are the means by which a country is built up populously and prosperously; bad roads delay civilization and cause districts to be sparsely settled, and poverty and ignorance to abound.

The railroad companies of this country, representing millions of employés and billions of capital, and controlled and directed by men of high intelligence, have a commanding influence in every legislative hall in the United States.

Every railroad corporation can request its officers, agents, and employés to do what they can to create a right sentiment in regard to the improvement of highways in their respective neighborhoods; and all along the various lines depot-masters and freight agents could report to a Road Department, established by the company, the condition of the roads in their towns and what is being done to improve them. These depot-masters could be furnished from time to time with pamphlets containing instructions for the construction and maintenance of highways, for distribution to persons doing business at their stations, and thus educate them how to build better roads, as well as teach them that better highways effect saving in transportation. Any railroad running through a territory hav-

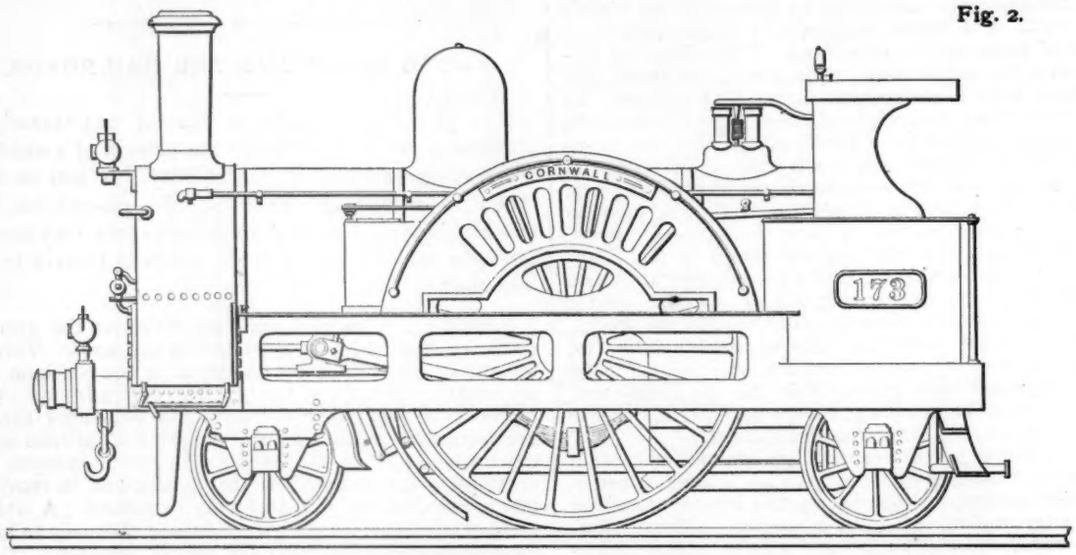
Fig. 1.



LOCOMOTIVE "CORNWALL."

As originally designed by J. Trevithick and built for the London & Northwestern Railway in 1847.

Fig. 2.



LOCOMOTIVE "CORNWALL."

As altered by Mr. Ramsbottom and Rebuilt in 1862–63.

ing good roads must have a great advantage over a competing line with poor roads from its stations.

The executive officers of a railroad corporation can instruct representatives in Congress on the importance of better highways so that favorable legislation may be secured; newspapers to whom railroad companies extend their patronage might be requested to devote space to agitating this matter.

The building up of suburban districts, which is of such a profitable character to railroads, is first brought about by the construction of good roads by those who wish to sell land.

Aside from the material advantages that may accrue to a railroad by its aiding in the work of agitating this subject, there is to be considered the broader question of the great benefits that might be conferred upon the entire community.

Will you not aid this great movement which is of so much national importance?

THE LOCOMOTIVE "CORNWALL."

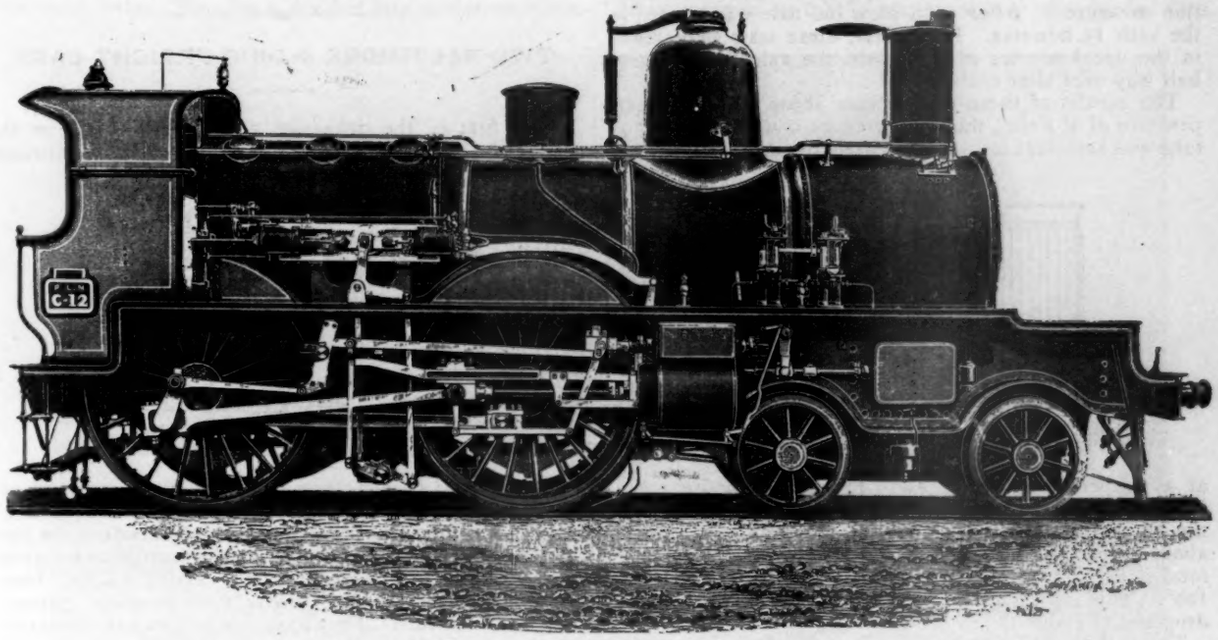
As the subject of large driving-wheels is now discussed a good deal, we have reproduced two engravings from the *English Mechanic*, which, it is said, "has been for some time past the engine with the largest driving-wheels in existence." It was described as follows by a correspondent in the paper referred to:

She was designed by J. Trevithick, and built in 1847, and was shown in the Exhibition of 1851. Fig. 1 represents the engine as originally constructed. The boiler, it will be seen,

went under the driving-axle, and she ran on eight wheels; but Mr. Ramsbottom rebuilt and altered her, in 1862–63, to her present state, as shown in fig. 2, with the exception of the cab, which has since been added by Mr. Webb.

Dimensions: Cylinders, 17½ in. diameter × 24 in. stroke; wheels, diameter of leading and trailing, 4 ft.; wheels, diameter of driving, 8 ft. 6 in.; weight of engine in working order, 63,840 lbs.

The object in building the *Cornwall* was to prove that the narrow gauge could have a larger driving-wheel—namely, 8 ft. 6 in.—than the Great Western—7 ft. gauge engines of that time. The *Cornwall* when new, it is said, attained a speed of fully 79 miles an hour, and to-day it can run as fast as any locomotive that exists.



COMPOUND LOCOMOTIVE FOR PARIS, LYONS & MEDITERRANEAN RAILROAD.

Mr. Clement E. Stretton, who is our authority on this subject, says that the largest wheels ever used were 10 ft. in diameter, with which the *Hurricane* on the Great Western Railway was fitted.

A FRENCH COMPOUND LOCOMOTIVE.

We have taken from the London *Engineer* the accompanying illustration of a compound locomotive designed for fast passenger work by M. Baudry, Chief Engineer of Traction of the Paris, Lyons & Mediterranean Railroad, and which has just been put in use on that road. The engine is of the same general design as the four-cylinder compound designed for the Northern Railroad of France by M. Du Bousquet, which was fully described and illustrated in the August number of the JOURNAL. In general it may be said that the engine is of the eight-wheel American type, with four driving-wheels, and a four-wheel truck forward. The high-pressure cylinders are placed outside, behind the truck or nearly in the center of the length of the barrel of the boiler, and are connected to the rear pair of driving-wheels. The low-pressure cylinders are under the smoke-box inside, and are connected to the forward pair of drivers through a crank-axle. The high-pressure cylinders are 13.40 in. and the low-pressure 21.25 in. in diameter, having 24.40 in. stroke. The driving-wheels are 6.56 ft. in diameter. The ratio between the high and the low-pressure cylinders is thus 1 : 2.42.

As in M. Du Bousquet's engines, there are separate valve-motions for the high and low-pressure cylinders, and the connections are so arranged that the engineer can reverse both with one motion or can move them separately for adjustment as he desires. The total weight of this engine is 48 tons, of which about 30 tons are carried on the driving-wheels.

The chief difference between this engine and that of the Northern Railroad is in the very high pressure used, which is intended to be 215 lbs. This is the highest working pressure yet used in a locomotive. The Northern Railroad engine was intended to work at 195 lbs. The boiler is, like those of many of the engines on the same road, provided with the Servé ribbed tubes, and from experience had with these tubes, it has been considered possible to make the boiler barrel shorter than is generally the case with engines of this size. The tubes are 10 ft. long or 2.8 ft. less than those of the Northern engine, but the heating surface as estimated is greater, being 1,620 sq. ft. The grate area is 25 sq. ft.

It may be added that the locomotive frames are of the plate type usually employed in France, and that both locomotive and truck frames are of steel. The truck-wheels are 39.37 in. in diameter. The first of these engines—the Company is building several at its works near Paris—is only just ready for service and has not been actually tried in actual work.

EFFECT OF TEMPERATURE ON THE STRENGTH OF AXLES.

(From the *Practical Engineer*.)

In a recent paper on this subject, read before the Institution of Civil Engineers, Mr. Thomas Andrews has given some data which he obtained from a series of experiments. The conclusions drawn from these tests compare closely with some results found in actual service that are cited in the paper. In the tests 18 axles were subjected to a cold test as follows:

The axles were allowed to cool gradually to a temperature of normal rigidity—that is, the atmospheric temperature at the time they were made. They were then buried separately in about 30 tons of snow, for various periods of time. When the axles were removed from this they were placed in a cooling cage, surrounded by a large quantity of freezing mixture, composed of two parts of snow and one part by weight of salt, for 13 hours, or until the metal

had become cooled to 0° Fahr. They were then placed in an axle drop on bearings 3 ft. 6 in. apart, and subjected to one blow from a one-ton weight falling from a height of 5 ft. The extent of deflection between the bearings was carefully taken after each blow. The axle was placed in the freezing mixture for 15 minutes after each blow was delivered, so as to make sure that its temperature was 0° throughout the tests. The operation was repeated until fracture occurred.

Warm tests were made with 11 axles. After forging, these axles were allowed to cool to a temperature of normal rigidity, and were then placed in a large water bath, which was gradually raised to 100° Fahr. Each axle was then removed to the drop test, and immediately tested in the usual manner, one blow being given and the deflection measured. After each blow the axle was placed in the bath 15 minutes. In general, these tests were made in the usual manner of drop tests, the axle being turned half way over after each blow.

The results of these experiments show that, at a temperature of 0° Fahr., the total average mean force of 179⅝ tons was sufficient to cause the breaking of the axle; and at a temperature of 100° Fahr. the total average mean force of 428⅛ tons was necessary to fracture—that is, the resistance to concussion at a temperature of 0° was about 42 per cent. of what it was at 100°. The average total deflection at 0° was 6.48 in. as against 15.06 in. at 100°. This represents a reduction of flexibility under the drop test of about 57 per cent.

The author of this paper gives the following conclusions on the whole series of observations made in connection with these tests, which have been proceeding during the last seven years:

1. The impact tests, with an energy of 10 foot-tons on axles, at a temperature of 212° Fahr., compared with the results at 7° Fahr., indicated an increase of endurance at the higher temperature of about 235 per cent.

2. The impact tests, with an energy of 15 foot-tons on axles, at a temperature of 120° Fahr., compared with the results at 7° Fahr., showed an increase of endurance at the higher temperature of nearly 120 per cent.

3. The impact tests, with an energy of 10 foot-tons on axles, examined at a temperature of 100° Fahr., when contrasted with results obtained at 7° Fahr., demonstrated an increase of resistance at the higher temperature of about 43 per cent., and this increase was within certain limits in proportion to the increase in temperature.

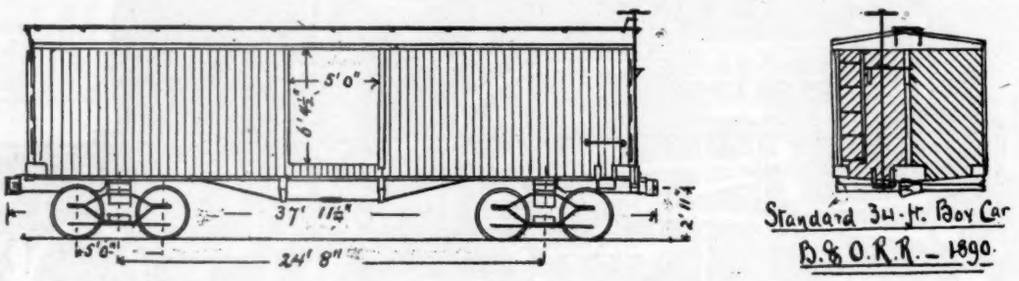
4. The impact tests, with an energy of 5 foot-tons of axles, at a temperature of 100° Fahr., gave an increase of resistance of about 138 per cent., compared with results on axles similarly tested at a temperature of 0° Fahr.

5. The impact experiments with an energy of 2½ foot-tons applied to axles with a temperature of 100° Fahr., compared with experiments at 0° Fahr., showed an increase of resisting power to concussion at the higher temperature of nearly 88 per cent.

The author also found that when axles were subjected to a number of heavy blows the extent of deflection was more during the earlier blows under same temperature than a deflection produced by later blows; that is, the elastic limit of the axles had increased. The progressive decrease of deflection was more clearly shown where the impacts were made at temperatures of 212°, 120° and 100° Fahr., but it was not observable when the axles were at a temperature of zero.

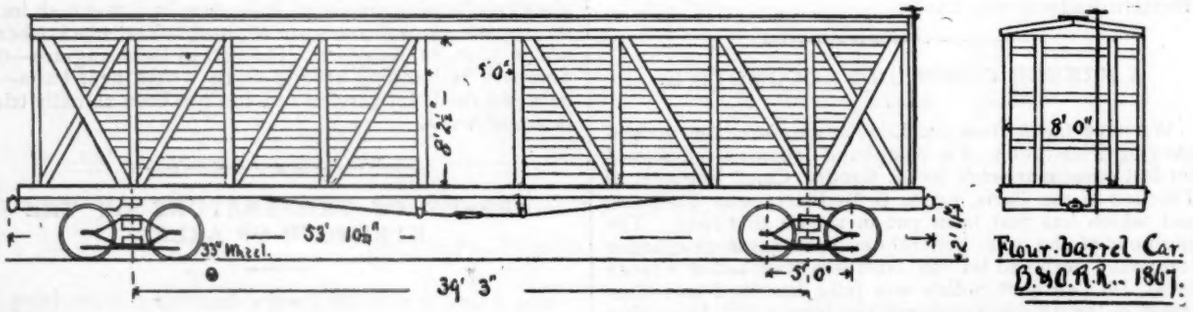
TWO BALTIMORE & OHIO FREIGHT CARS.

THE first of the drawings given herewith shows the standard 34-ft. box car of the Baltimore & Ohio Railroad. This car is 34 ft. 8 in. long over end-sills; 37 ft. 11¼ in. outside of draw-heads, and 34 ft. inside. It has a clear inside width of 7 ft. 10 in., and its height inside in the center is 6 ft. 9¾ in. The other general dimensions are given in the drawing. These cars are carried on two four-wheel trucks of the company's latest standard pattern, with 33-in. wheels. They have air brakes and automatic couplers of the M. C. B. standard type. The total weight of the standard car is 29,550 lbs., and it is rated at 50,000 lbs. capacity. It may be added that the grain-lining inside is 4 ft. in height. The first car of this pattern was built in 1890, and it is a good type of the later practice of this road.



The second drawing shows a car of a peculiar type, which was designed for and built on the same road some years ago, but of which, we believe, only a small number were constructed. It was intended especially for carrying flour in barrels, and had capacity for a large load—360 bbls., or about 72,000 lbs. It is 52 ft. long over end sills; 7 ft. 4½ in. wide inside; 8 ft. wide outside, and 8 ft. 4 in. high. It is sheathed only on the inside, and the ends are open as shown. The door has a clear opening of 8 ft. 2½ in. × 5 ft., and the general object seems to have been to make the handling of barrels and their stowage easy. The trucks are 39 ft. 3 in. apart between centers.

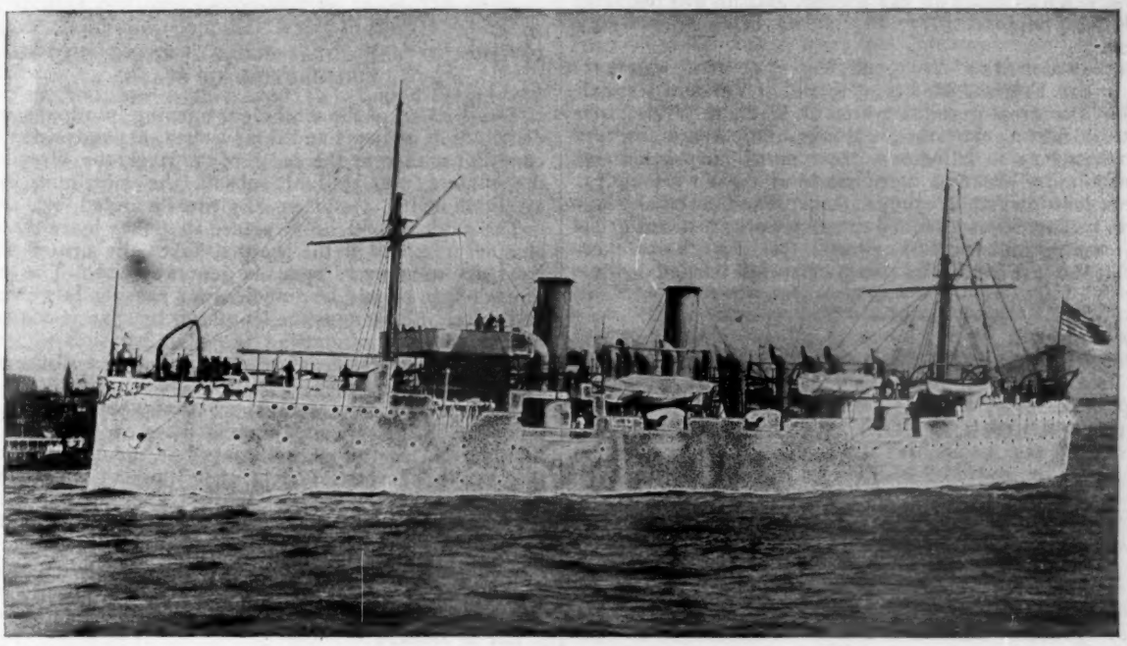
The general construction of this car will be readily understood from the drawings. While only a few of these cars were built, we believe, it is given here as an interesting special type of car.



THE CRUISER "PHILADELPHIA."

THE accompanying illustration is from a photograph of the cruiser *Philadelphia*, one of the handsomest cruisers of the Navy in general appearance, and a cruiser of a high class, corresponding nearly to the *Charleston*, *Newark*, *San Francisco* and *Baltimore*.

The *Philadelphia* was built at the Cramp yards in Philadelphia, and was launched in September, 1889. She is an unarmored steel cruiser of 4,400 tons displacement, 335 ft. long, 38½ ft. in width, and 16½ ft. mean draft. Though without side armor, she has a protective deck, varying in thickness from 4 in. over the engines to 2 in. at the extreme ends, and the coal bunkers are so arranged as to protect the machinery. The ship is divided into numerous water-tight compartments, and has the latest approved arrangements for ventilation, electric light, etc.



CRUISER "PHILADELPHIA," UNITED STATES NAVY.

As originally designed she was to carry three masts with fighting tops, but it was subsequently considered best to replace these by the light wooden masts shown in the engraving.

The *Philadelphia* has twin screws, each driven by a separate triple-expansion engine, with cylinders 38 in., 56 in. and 86 in. in diameter and 40 in. stroke. The engines are supplied with steam by four boilers, each 14 ft. in diameter and 20 ft. long.

With forced draft the boilers carry 160 lbs. pressure, and the engines work up to 10,500 H.P. The guaranteed speed was 19 knots an hour. On the trial trip this was exceeded, the ship making a speed of 19.6 knots an hour.

There are several auxiliary engines, which run the pumps, ventilators, dynamos, etc.

The main battery consists of twelve 6-in. breech-loading rifled guns, two mounted forward, two aft and eight in broadside. The broadside guns also have a considerable fore-and-aft range. The secondary battery includes a number of smaller rapid-fire and machine guns, and there are five torpedo-tubes, two in the bow, one aft and two in broadside.

SOME LOCOMOTIVE HISTORY.

(From a *History of York County, Pennsylvania*, by John Gibson, Historical Editor.)

The First Locomotive in America that Burned Anthracite Coal.—As described in the history of railroads in this work, a reward was offered by the Baltimore & Ohio Railroad Company for the best steam engine of American Manufacture. Phineas Davis, one of the proprietors of the York Foundry, was an inventive genius and an intelligent Quaker. He determined to compete for the prize, and began the construction of an engine in his York shops. It was completed in July, 1832, and conveyed in wagons to Baltimore, as the railroad to that city was not yet built.

The Baltimore *Gazette* of July 31, 1832, says: "We are gratified to learn that the locomotive steam engine, *The York*, constructed by Davis & Gardner, of York, Pa., commenced here operations on the Baltimore & Ohio Railroad under the most favorable auspices at 9 o'clock. It started from Pratt Street depot for Ellicott's Mills, with the entire train destined for that place, consisting of 14 loaded cars, carrying, with the engine and tender, a gross weight of 50 tons. The whole went off in fine style, and was soon out of sight. We have not had any news of the cavalcade since its departure, but understand that no fears are entertained of the abilities of the engine to perform the duty which has been laid upon it. A gentleman present says it was out of sight of the depot in about six minutes, and the rapid gliding of the immense train was one of the most imposing and beautiful spectacles he ever witnessed."

The York *Gazette* of August 9, 1832, states that it made the journey—13 miles—in one hour and five minutes. Made the journey back with one car, a passenger coach, in 57½ minutes.

The trial journey was made Saturday, August 4, 1832. The train, exclusive of tender, consisted of seven cars, weighing 25 tons. The fuel was anthracite coal.

Edwards's *American Locomotive Engineer* says: "In 1832 Davis & Gardner, of York, Pa., built several locomotive engines of the 'Grasshopper' type for the Baltimore & Ohio Railroad, from designs by Phineas Davis and Ross Winans. These engines have vertical boilers similar to those now used on steam fire engines, 51 in. in diameter, and containing 282 fire tubes 16 in. long (?) and tapering from 1½ in. at the bottom to 1¼ in. at the top, where the gases discharged through a combustion chamber into the stack. These engines weighed about 6½ tons. One of these engines, the *Atlantic*, was set to work in September, 1832, and hauled 50 tons over a rough road with high grades and short curves at the rate of 15 miles per hour. This engine made a round trip at the cost of $16, doing the work of 42 horses, which had cost $33 per trip. The Baltimore & Ohio Railroad exhibited one of these engines at the Centennial Exhibition, Philadelphia, in 1876, and

there are one or more still used as shifting engines at Mount Claire station, Baltimore, Md."

In competition with other engines, Phineas Davis won the first prize of $3,500 for making the first engine in America that was successfully worked that burned anthracite coal.

He soon afterward removed to Baltimore, when he became Superintendent of the large shops of the Baltimore & Ohio Railroad, and prospered in his enterprises. He was a diligent worker. Mr. Rupp, of Hanover, now living, was one of his employés. Davis lost his life by accident. He had command of one of his engines, and was taking a party of Baltimoreans on an excursion, when a few miles out from the city one of the iron rails on the left side of the track bent and broke, flew with great force backward, and struck him while on the engine, and he was instantly killed, on September 27, 1835. His death was deeply lamented.

He was a native of York, and August 15, 1826, was married in the Friends' Meeting House, at York, to Hannah Taylor, the great-granddaughter of William Willis, who built the first court house. He was only about 40 years old when he was killed. A great many car wheels and other foundry products were made at the York foundry. It was last owned by Judge Ducker and Samuel Slaymaker. There was attached to these works a steam grist-mill, carding-mill and fulling-mill. Joel Fisher was manager of the last two. The steam grist-mill burned down.

CROSSINGS OF GREAT RIVERS.

A CONTRIBUTION TO RAILROAD LOCATION.

By A. Zdziarski, C.E.

(Copyright, 1892, by M. N. Forney.)

(*Concluded from page 469.*)

THE REQUIRED DEPTH OF FOUNDATIONS.

The required depth of the foundations of the abutments and piers should be calculated by the formula of Rankine, which we find suitable in the form

$$h > H' \, tang.^4 \left(\frac{90 - \phi}{2}\right),$$

where H' is the height of a column of sand, whose weight is equal to the weight of the structure, ϕ is the angle of repose or of natural slope of the ground (for sand $\phi = 30°$; for clay, $=35°$); and h is the required depth of foundation.

The value of H' is computed in the following manner: If n is the weight of the structure with the load transmitted to it by the superstructure—its dead and living load; F = the area of base, and $\Delta = \frac{n}{F}$, the pressure on a square unit of the base and δ the weight of a cubic unit of sand, then

$$H'\delta = \Delta \quad \therefore H' = \frac{\Delta}{\delta},$$

and the formula can be written

$$h > \frac{\Delta}{\delta} \, tang.^4 \left(\frac{90 - \phi}{2}\right).$$

If, after the washing out of the bed, the depth of base of the foundation is H, then it is necessary that the coefficient of stability m be:

Before washing out,

$$m = \frac{H}{h} = \frac{2}{\ldots}$$

After washing out,

$$m' = \frac{H + l}{h} = \frac{3.25}{3.5}$$

Observation.—For the abutments the pressure from the earth behind should be taken into consideration.

ELEVATION OF THE SUPERSTRUCTURE ABOVE HIGH WATER.

For construction of truss bridges over great rivers, two chief conditions as to the elevation should be satisfied:

1. The base of the pier masonry should rise 1½ ft. above the level of highest water.
2. The lower flange of the girders should be so elevated that the largest vessels in use on the river can pass under them.

DIVISION OF THE TOTAL CLEAR OPENING INTO SPANS—DISTRIBUTION OF SPANS.

The division of the total clear opening into spans, or the distribution of spans and their length, depends upon local conditions, such as the depth of the river, the direction of the current, the kind of subsoil, the maximum length available under the system of girders adopted, etc.

The piers should be so placed that they leave the main channel free, and if the channel takes the center of the river, the number of spans is generally odd. The length of each span should be sufficient for passing large vessels and rafts. Sometimes the length of the span is controlled by the necessity of putting the piers on sites where the foundations are easily made, and in that case all the spans do not need to be equal.

As a general rule, we can say that when the spans are longer, then the superstructure is more expensive, and the number and cost of piers are less; on the contrary, when the length of spans is less, then the superstructure is cheaper, and the piers cost more. Therefore, the length of spans should be so chosen that the total cost of the bridge be the least.

For bridges with metallic superstructure and stone piers founded on caissons, we can suggest the following considerations:

Let us assume

l = total clear opening of bridge in feet,
x = the most advantageous length of span;

then the weight of a lineal foot of superstructure in pounds is given by a formula of the form $Cx + F$, where C and F are constant co-efficients, F designating the weight of the floor.

Further, let

p = price of a unit weight of metal,
P = total cost of one pier;

then the total cost of the bridge K is

$$K = (Cx + F)p\,l + \left(\frac{l}{x} + 1\right)P.$$

In order to find the value of x, corresponding to the minimum of K, differentiate this equation, and put $\frac{dk}{dx} = o$; then

$$\frac{dk}{dx} = Cp\,l - P\frac{l}{x^2} = o;$$

therefore

$$x = \sqrt{\frac{P}{Cp}}.$$

For ordinary trusses 200 to 400 ft. in length—of the Linville or a similar system—the quantity C has a value of 7.5 to 8.5, in pounds, the value of p can be assumed at 4 to 5 cents per pound, and the value of P = a sum which may be calculated on the basis of local prices of stone, cement, and other materials.

In the case of a majority of the larger bridges, the arrangement of spans has been determined by extraneous considerations, chiefly by the location of the current and the nature of the navigation. It may be said in a general

way that this is one of the most difficult questions to decide, and that it is almost impossible to determine it by any fixed formula. It is here that the judgment of the engineer will be best displayed, and the exercise of his best faculties will be required.

ELECTRICITY IN WELDING AND METAL WORKING.

(Paper read by A. B. Wood, of Detroit, and published in the *Proceedings* of the American Institute of Mining Engineers.)

IN welding and metal working by electricity two systems are in use: the so-called *Incandescent System*, in which the material operated upon is traversed by currents of large volume and low electro-motive force, the current having a continuous metallic circuit during the welding operation; and the *Arc System*, in which the electric arc is utilized.

It is the purpose of this paper to call attention to this last system of electric welding as one of the recent developments in the art of metal working.

In the arc system of electric welding the material may be included in the electric circuit, or may be wholly without the circuit; in either instance the enormous heat of the electric arc is brought into requisition and utilized in the welding or metal-working operation.

In the Coffin arc-welding system, invented by C. L. Coffin, of Detroit, the material is in the electric circuit or independent of it, as the case may require, different processes being applied as may be best suited to the work.

It is not the intention in this paper to give a description of the various machines and appliances employed, as improvements are being perfected and the inventor prefers to hold such descriptive matter in reserve until he shall have secured the protection of patents.

The apparatus used in this arc system of metal working is of the simplest character. It can be used upon continuous or alternating currents, upon light or power-circuits, either arc or incandescent.

In the earlier attempts at arc welding with the Bernardos process, difficulty was experienced in obtaining clean and homogeneous welds. This objection does not apply to the Coffin system.

In the Bernardos process the material is connected to one terminal of the generator, and the tool, generally a carbon electrode, connected to the other terminal. Contact is made between the tool and material to establish the circuit, and an arc is sprung between the tool and material by separating them slightly after the current has been turned on. The carbon electrode is slowly traversed along the point or part to be welded, the intense heat of the arc fusing the metal at or in the neighborhood of the joint. Since the regulating and maintaining the arc at proper length is done by hand, much difficulty is experienced in securing a uniform arc, while the regulation of the dynamo is almost an impossibility; the material is subjected to too severe treatment and, in many instances, notably in working on steel or iron, a chill is formed at the weld, or the metal is overheated and greatly oxidized.

With the Coffin system of arc welding this difficulty is entirely obviated, the material not suffering in the least from the treatment; clean, neat welds are made with but little oxidation; no chilling or burning is manifest; the arc is under perfect regulation, and the heating of the material is entirely under control of the operator. Generally no flux is used in the welding operation, so slight is the scaling or oxidation, though, if desired, fluxes may be used in special instances, as in the welding of polished metal.

This arc system of metal working is of very general adaptability, being readily applied to bar, shaft, axle, ring, hoop, tire, pipe, sheet-metal, angle-iron, frame and boiler-work. A 1 H.P. arc welder has a capacity up to one inch of round iron; its cost of maintenance is but a few cents per day for power supplied at the dynamo when power is rented, or at a rating of a single arc lamp when current is supplied from light or power circuits.

A welder of 1 H.P. has a capacity of one weld per 15 seconds, operating upon ¼-in. round-iron. This capacity can be increased according to the skill and rapidity of the operator. The same welder handles ½-in. and ⅝-in. round iron with equal facility, and can be utilized upon ¾-in. and 1-in. work. The butt welding of pipe is obtained with the same ease and perfection of results.

The arc system of welding seems destined more especially to give material aid in work on sheet metal, tubes, and boilers, since the tremendous heat of the arc can be readily applied where most needed. The heating of the material is not dependent upon its electrical resistance, or its current-carrying capacity, nor is perfect contact at the joint a necessity; while these are points of the utmost importance in operating upon such work under the incandescent system. With that, the current required to weld a 5-ft. seam in ½-in. iron plates is something enormous, and the cost of generator and of power to drive it is correspondingly great; while under the arc system the plant required would be insignificant in comparison. It is not the intention of the writer to disparage the incandescent system of electric welding, for it has great use, but to call attention to the fact that arc welding is an established process, in successful operation, and bids fair to assume a position of great importance in metal-working operations.

The mechanical application of arc welding is readily made. Since the material may be either within or without the circuit, and the heating effect is independent of the current-carrying capacity of the material, no exacting provisions have to be made for electrical contact, or large current-carrying capacity in the material itself. Hence heavy copper castings and retaining clamps are unnecessary; no cooling appliances are required, and in most instances the welder proper may be applied to existing apparatus or machinery with slight alteration. An advantage of this method may be noticed in the welding of hoops and tires, in that it does not require special precautions to prevent short circuiting of the current around the joint, or the use of an abnormal current to cover the effects of such a short circuit, or shunt, should it occur. A hoop of ½-in. or ¾-in. round iron is neatly and rapidly welded on a 1 H.P. arc welder; a feat quite impossible with like power under the incandescent system.

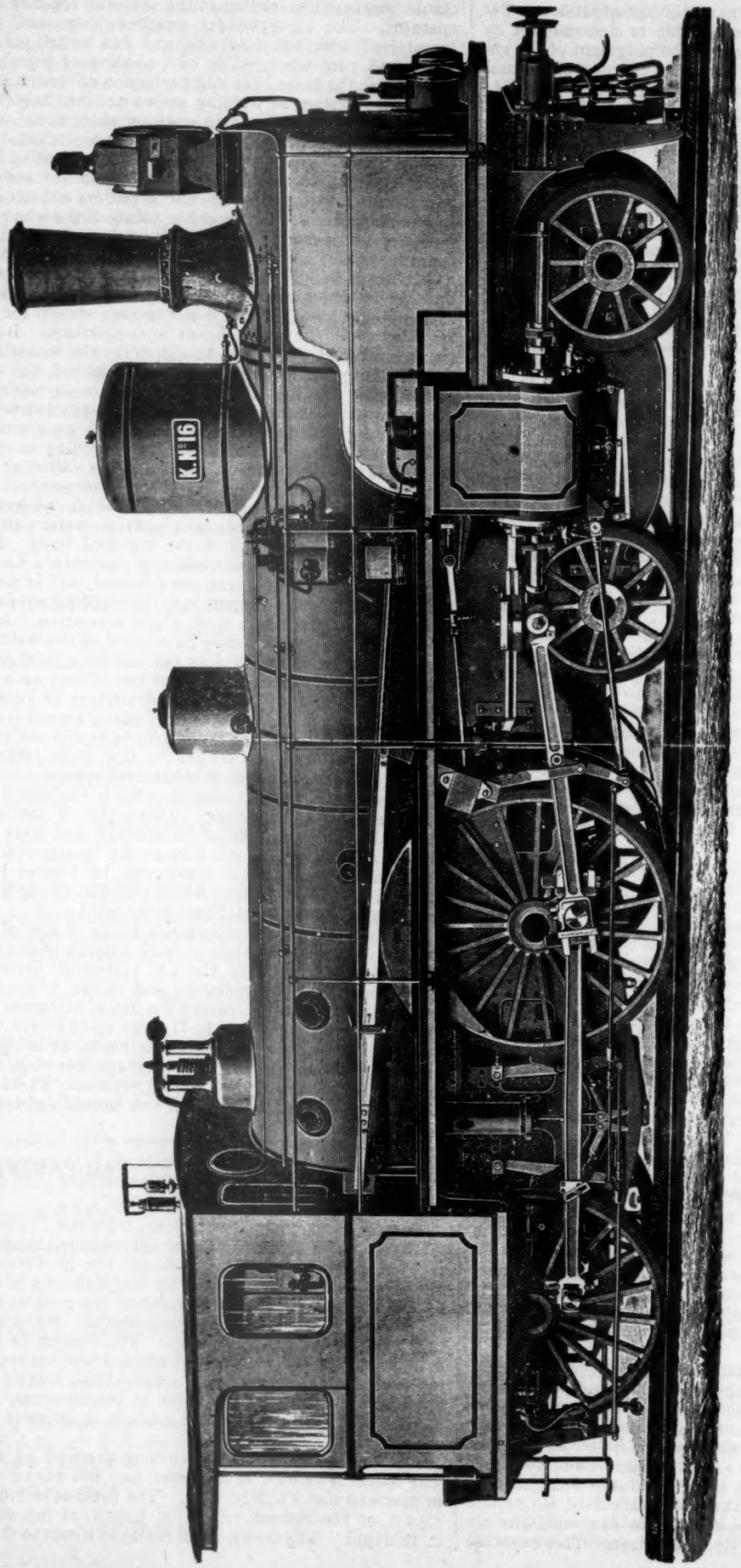
With larger power the work possible to be done is much more general in its nature. With a 50-H.P. arc welder work of large proportions can be handled, and large shafts welded as readily as small bars on the lighter machines. Rails, shafts, and similar work may be treated in this way. It must be especially noted that the iron is left in a very soft and natural condition at the weld.

The simplicity of the apparatus, its small cost of maintenance, and the wide range of work possible with a welder of small power renders the arc system of interest to bridge builders, mine operators and others, whose operations in the field do not permit the use of extensive power plants and generators. A 10-H.P. or 20-H.P. arc welder has capacity for most of the work called for in bridge construction, such as welding eye-bolts, spanner rods, plates, etc., and for repairs needed during erection. The dynamo used for welding in the daytime can be utilized for lighting at night.

A COMPOUND LOCOMOTIVE FOR PASSENGER SERVICE.

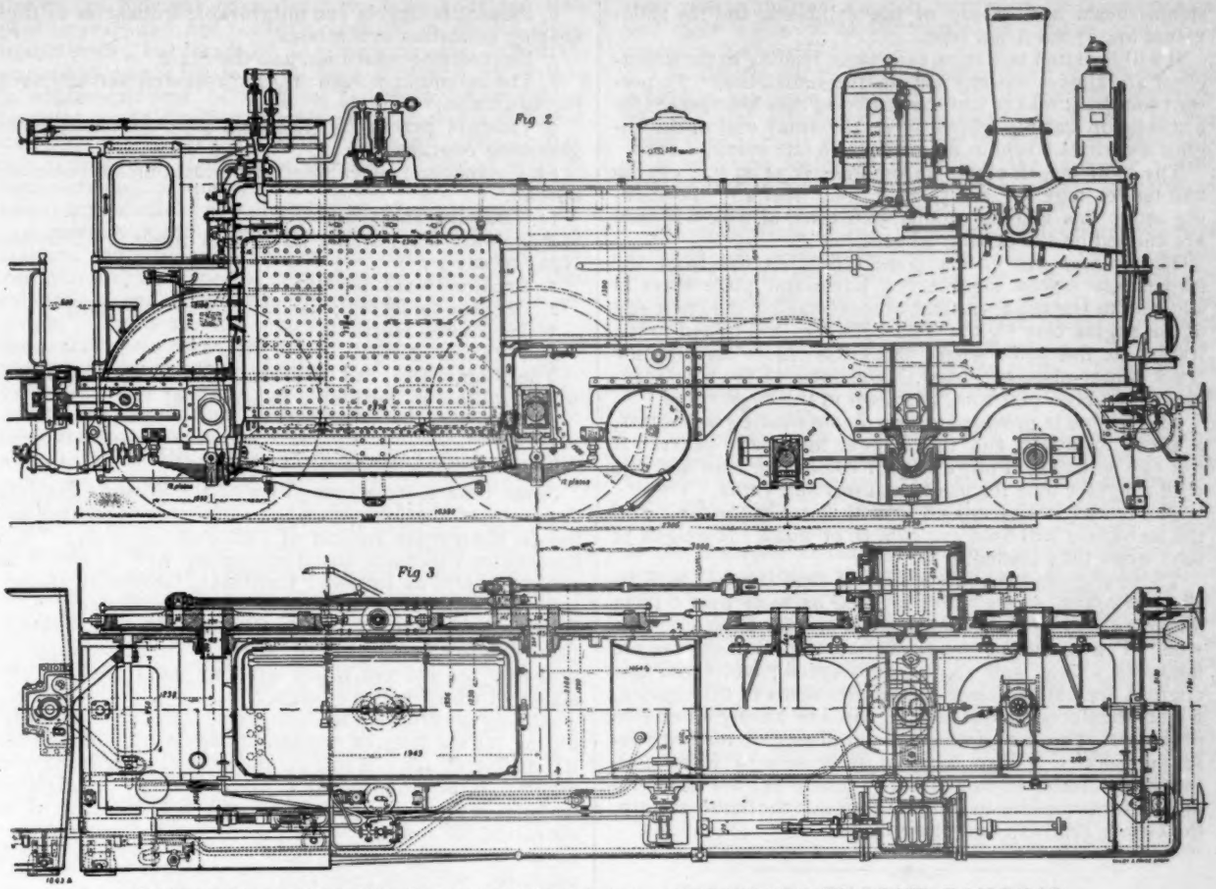
THE accompanying illustrations, from the London *Engineering*, show one of a number of compound locomotives for fast passenger service, built for the St. Petersburg-Warsaw Railroad, in Russia, by the Kolomna Works in St. Petersburg. The first illustration is a general view of the engine; fig. 2 is a longitudinal section; fig. 3, a plan; figs. 4 and 5 are cross sections. The engine is a two-cylinder compound of the eight-wheel American type, having four coupled wheels and a four-wheel truck; it presents some notable peculiarities of construction, having a mixture of European and American features in its design.

The boiler is built for a working pressure of 165 lbs. The barrel is 54.8 in. in diameter, and has 220 tubes 2 in. in diameter and 13.78 ft. long. The fire-box is 7.94 ft. × 3.53 ft. at the bottom, 7.71 ft. × 3.73 ft. at top and 5.76 ft. in depth. The crown-sheet is stayed direct to the outer



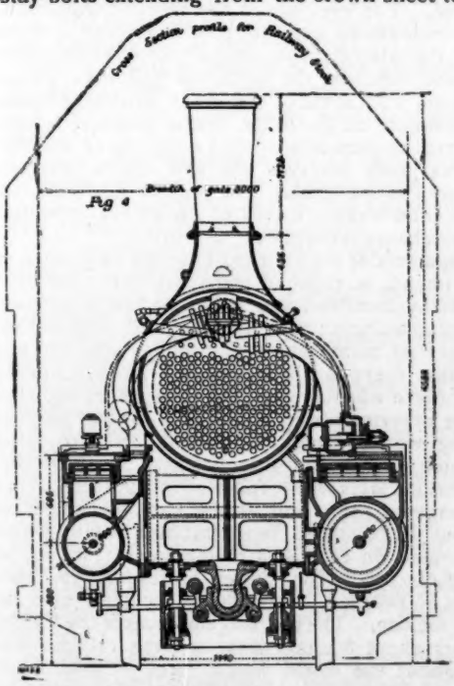
COMPOUND LOCOMOTIVE FOR FAST PASSENGER SERVICE, ST. PETERSBURG-WARSAW RAILROAD.

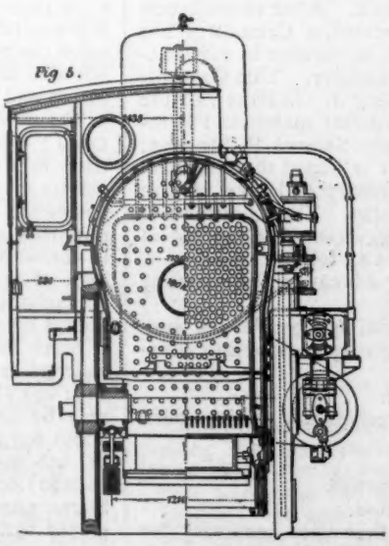
BUILT BY THE KOLOMNA WORKS, ST. PETERSBURG, RUSSIA.



COMPOUND PASSENGER LOCOMOTIVE, ST. PETERSBURG-WARSAW RAILROAD.

sheet of the boiler by stay-bolts over a large part of its area; but at the front end these are not continuous, short stay-bolts extending from the crown-sheet to a transverse bar, which in turn is stayed to the boiler shell by others. This arrangement is shown in figs. 2 and 5. Other transverse stays tie the sides of the shell above the fire-box, compensating for the strains thrown upon the shell by the direct stays.





There is an extended smoke-box 4.93 ft. in length. The boiler is long, 26.85 ft. over all. The grate area is 26.5 sq. ft.; the heating surface is: Fire-box, 134.6; tubes, 1,437.4; total, 1,572 sq. ft. The fuel used is wood. With the water 4 in. above the crown-sheet the boiler will hold 160 cub. ft. of water, and has a steam-space above the water of 73 cub. ft. The center of the boiler is 7.47 ft. above the rails, and the top of the chimney is 17 ft.

The driving-wheels are 78 in. in diameter, and the driving-axle journals are $7\frac{1}{4} \times 10\frac{1}{4}$ in. The truck wheels are $43\frac{1}{4}$ in. in diameter, and the truck axle bearings are $6\frac{1}{2} \times 10\frac{1}{4}$ in. in size. The truck axles are 7.57 ft. between centers, and the distance from center of truck to center of forward driving-axle is 11.61 ft. The driving-axles are well spread, being 9.83 ft. between centers. The truck is set well back, and the long smoke-box projects well over the forward wheels. The truck is of the swing-bolster type, and has a plate frame.

The high-pressure cylinder is 18.13 in. and the low-pressure 26.38 in. in diameter, both being 25.57 in. stroke. The ratio of the two cylinders is 1 : 2.12. The connecting-rods are 6.89 ft. long. The high-pressure cylinder has steam ports 11.81×1.78 in. and exhaust ports $11.81 \times 3\ 38$ in.; its valve has $1\frac{1}{8}$ in. outside lap and $\frac{5}{32}$ in. inside lap. The low-pressure cylinder steam ports are 20.50×1.78 in. and its exhaust ports 20.50×3.38 in.; its valve has $1\frac{1}{8}$ in. outside lap and no inside lap. Both valves are given $\frac{5}{16}$ in. lead. They are driven by the Joy valve gear. The

steam-chests are on top of the cylinders, and the slide-valves are of the Allen type.

It will be noted that the steam-pipes leading to the steam-chest are almost entirely outside the smoke-box. To prevent too great loss of heat by radiation they are covered by a sheet-iron casing, which gives the front end of the engine a curious boxed-in appearance to our eyes.

The total length of the locomotive is 34.03 ft.; engine and tender together are 57.28 ft. long over all. In working order this engine weighs 50.6 tons, of which 26 tons are carried on the driving-wheels.

The frames are of the plate type. At the front the frames are stayed together by horizontal plate stays in addition to the usual vertical braces, making the front end of the engine very rigid. The cylinders are bolted to the frames at the point where the cross-braces carrying the truck center-plate are fixed. The form of the truck center, which is of cast iron, is shown in the engravings.

The engine is provided with a steam sanding apparatus, a speed indicator, and the Wenger automatic brake. It has two whistles—a large one for use on the road and one with a lighter tone for use in stations and yards.

The tender can carry 13.8 tons of water in the tank, and the fuel-space will hold 472 cub. ft. of wood. It weighs 34 tons when fully loaded.

These engines have larger drivers than is usual on Russian railroads, where there are few or none over 6 ft. in diameter, and 66 in. is a more usual size for passenger service. The trains on the St. Petersburg-Warsaw line are heavy as a rule, and run at high speed; and these new engines are built to meet the requirements of this service, which the locomotives now in use are hardly able to do properly. The use of the compound engine for fast passenger service is also comparatively new in Russia, although a number of compound locomotives have been employed for some time in freight service on the Southwestern, the Griasi-Tzaritzin and other roads.

CONGRESSES AT THE COLUMBIAN EXPOSITION.

CONGRESS OF ENGINEERING SCHOOLS.

In addition to the other meetings to be held at Chicago next year, the Exposition seemed an excellent opportunity to bring together persons interested in Engineering Schools, the object being not simply a conference of professors among themselves, but a conference with practicing engineers, and the obtaining of suggestions from those who have had experience in the field. After consultation among a number of persons interested, a Committee has been formed to arrange for such a conference in combination with the World's Congress Auxiliary. This Committee has for its Chairman, Professor I. O. Baker, of the University of Illinois, and for its other members Professors W. T. Eddy, William R. Hoag, Samuel R. Stratton, Storm Bull and M. E. Cooley. It is hoped that teachers of engineering throughout the country will take part in presenting papers and by discussion. The Chairman of the Committee presents some suggestions for the list of subjects to be discussed, which are as follows:

1. Present state of engineering education (for as many countries as possible).

a. Historical outline as to origin, age, grade and support of the schools and colleges giving engineering edcation.

b. Qualifications for admittance.

c. Courses of study in civil, mechanical, mining, military and naval engineering.

d. Equipment.

e. Laboratory work and field practice.

2. The ideal engineering education.

3. Maximum and minimum mathematics necessary for an engineering education.

4. Modern languages in collegiate engineering courses of study.

5. How many weeks per year, how many days per week, and how many hours per day should a student give to collegiate work?

6. Present favorable and unfavorable tendencies of engineering education in America.

7. Engineering education and the State.

8. The relation between original research and engineering education.

9. Views of practicing engineers as to the needs of engineering education.

10. Comparison of engineering education at home and abroad.

11. Drawing and shop work.

Additional suggestions have been made by Professor Hoag to cover:

1. Vacation work.

2. Degrees conferred; desirability of uniformity.

3. Graduation thesis.

4. Technical essays.

The Committee, we understand, solicits suggestions which will aid in forming a programme.

CONGRESS ON RAILROAD COMMERCE.

Some time since a committee of the World's Congress Auxiliary of the Columbian Exposition was appointed having in charge the subject of Railroad Commerce. This Committee was made up of gentlemen well known in the railroad world as follows: Chairman, George R. Blanchard; Secretary, H. R. Hobart; A. F. Walker, E. T. Jeffery, John Newell, Edwin Walker, M. M. Kirkman, John W. Cary and George B. Reeve. This Committee has prepared an address which explains itself and the substance of which we give below:

Among the international congresses to be held at Chicago during the six months' season of the World's Columbian Exposition of 1893, is one on the subject of railroad commerce. It is proposed to convene on that occasion the leading representatives of the railroad interests of all countries, for mutual acquaintance and the consideration of the means by which their common interests may be promoted and their general welfare advanced.

Among all the subjects which now deservedly attract public attention none can exceed in importance that of the transportation of the products in the exchange of which commercial activity exists, and without which the great affairs of civilized life could not be conducted nor even preserved. The creation of the railroad world is so recent; its development and progress have been so rapid and so vast; the interests which it embraces are so varied and so extensive, touching the welfare of millions of people on the one hand and some of the most important operations of government on the other, that a proposal to consider these great themes in a world's congress of railroad representatives justly deserves and will undoubtedly receive the respect and attention, not only of railroad men, but also to a considerable extent of producers, manufacturers and merchants throughout the world.

The developments of the railroad business have been so rapid; experiments in railroad transportation have been tried in so many localities and under so many different classes of circumstances; and the results of different experiments have so many points of peculiar interest and importance, that there is obviously the highest propriety in convening those who have had the supervision and conduct of those experiments in a congress for the purpose of exchanging views, comparing results and proposing means by which their mutual interests may be advanced.

A few important facts will emphasize this position. The railroad mileage of the world at the commencement of 1892 was about 395,000 miles, representing a capital which may be estimated on the basis of the latest returns, at about $25,000,000,000. The United States has now over 171,000 miles of railroad, representing a capital of more than $11,000,000,000. The railroad employés of the United States number about 850,000 men, and the railroad employés throughout the world would form an army of at least 4,000,000. Every year, according to the average of the last five years, nearly 14,000 miles of railroad lines have been built in this and other countries, and when the World's Columbian Exposition shall open, the total mileage of the main railroad lines of the globe will be at least 410,000 miles. It might be supposed that railroad statis-

tics of the different countries have been collected from year to year, and are readily accessible to all who desire to use them; but this is by no means the case. On many important points the most valuable statistics are lacking in whole or in part. One of the benefits to be anticipated from the world's railroad commerce congress is the adoption of a world-wide plan for the collection, classification, and exchange of statistics in relation to railroad mileage, capitalization, equipment, number of employés, and other important relations of railroad commerce.

Another subject of immense importance to both the railroad companies and the general public, is that of State and national laws for the regulation of railroads in their relation to the people, to each other, and to their employés. The deliberate and thoughtful consideration of the practical results of governmental regulation and supervision; of the question whether such supervision should be restricted or extended; of the best means of preventing and of settling conflicts between railroad companies and their employés, and various kindred subjects, would excite an interest as deep and as widespread as may be anticipated for any other subject which will be presented at any other congress embraced in the entire series.

Such a congress would naturally embrace the railroad commissioners of the various participating States and Nations, as well as representatives of various railroad corporations. Such State and national commissioners might appropriately be convened under the leadership of the Interstate Commerce Commission of the United States, and facilities will of course be afforded for meetings of such commissioners apart from as well as in connection with the representatives of railway companies. Opportunity will be given for a comparison of the methods and results of railroad regulation in various countries as presented by governmental officials, in contradistinction to the presentation to be made by railroad officials.

To indicate the general scope and purposes of the proposed Railroad Commerce Congress the following themes, suggested by the President of the Auxiliary in organizing the Department of Commerce and Finance, are here given for the purpose of eliciting from all who may be interested the recommendation of such additional or different topics as may be deemed proper for the occasion:

a. The origin, development and present condition of railroad commerce in different parts of the world.

b. The influence of railroad commerce on the settlement and development of new countries.

c. The practical results of railroad commerce to producers, carriers, and consumers.

d. The proper elements of the cost of safe and efficient service.

e. The practical effects of free competition in the construction and operation of railroad lines.

f. The proper protection of the public rights and interests involved in railroad commerce.

g. The proper protection of private rights and interests involved in railroad commerce.

h. Railroad strikes; what should be done in the way of prevention and control.

i. Railroad employés; what should be done for their protection and improvement.

j. Railroad accidents; their causes and the practicable safeguards against them.

k. Railroad receiverships; the practical lessons they teach.

l. Governmental regulations of transportation and practical results thereof.

m. Freight traffic; special contracts, limitations of common law liabilities, railroad clearing houses, traffic pools, etc.

n. Baggage; checking systems and delivery; claims for damages, limitations of liability; restrictions of quantity, etc.

o. Passenger tickets; defects of existing systems; special contracts and conditions; limitations of time; through tickets; commutation tickets; zone tariffs, etc.

p. Police powers of railroad-train officials, and the best means of guarding against frauds on the carrier and against injury to passengers through accident or mistake.

q. Interstate and international railroad arrangements; their practicability; the best means for their promotion and their influence on the commerce, peace and prosperity of the world.

The subject of railroad construction, equipment and operation has been assigned to the department of engineering, and will there be considered in detail. It was thought important to relieve the railroad commerce congress of these topics, in order that the immense public and private interests involved in the subject of railroad commerce may have undivided attention.

The congresses of the Department of Commerce and Finance will commence June 19, 1893. The meetings will be held in the World's Congress Art Palace, now in process of erection on the lake front park at Chicago, in which there will be two large audience rooms capable of seating 3,000 persons each, and more than 20 smaller rooms for meeting of chapters and sections. These places of meeting will be furnished free of expense, for the various congresses.

Each congress is in charge of a local committee of arrangements, and this committee will be assisted by an advisory council selected from all of the various participating countries, and consisting of the most eminent representatives of the interests involved. The advisory council of the Railroad Commerce Congress will be selected and announced as soon as practicable, and in the mean time the State and national commissioners or other officials of all countries, and the officers of railroad corporations throughout the world, are cordially invited to furnish the above-mentioned committee at their earliest convenience with their suggestions of the themes which it would be most useful to consider in the proposed congress, of the persons by whom such themes may most advantageously be presented, and of the modes of proceeding by which the most satisfactory and useful results may be secured.

PROGRESS IN FLYING MACHINES.

By O. Chanute, C.E.

(*Continued from page 465.*)

Fig. 52 exhibits an apparatus patented in 1871 by M. *Danjard*. This was to consist in parachute-like sails in front and at the rear, between which were to be placed two sustaining aeroplanes, between which again there was to be a pair of vibrating wings, which, in connection with

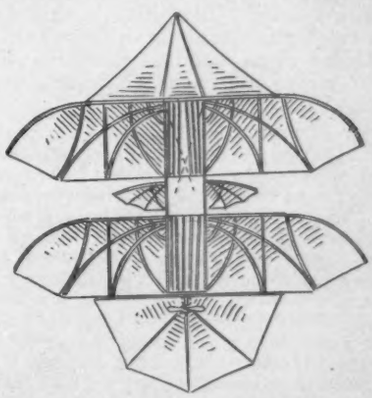


Fig. 52.—DANJARD—1871.

a screw, placed behind the car, were to furnish the impulsion. The front parachute was to be triangular in form, and made strong and rigid to cleave the air, while the rear parachute and the two aeroplanes were to be made flexible in the rear, so as to obtain a horizontal thrust from the escaping air compressed at the front. Under the rear parachute there was to be a rudder, to move to the right or to the left, and the machinery and aviators were to be in the central car. No motor is indicated save hand-power, but, of course, any primary motor could be applied if it were only light enough.

The apparatus is not known to have been experimented with. Probably M. *Danjard* dropped a lot of paper models and found that the arrangement of planes in pairs was more stable than a single aeroplane, and the figure is here given to show a combination which will be seen to have given fair stability in other experiments to be hereafter described.

The next experiment to be mentioned was important and quite successful upon the small scale on which it was tried. Fig. 53 represents an aeroplane with automatic equilibrium, produced in 1871 by M. *A. Pénaud*, who called it his "planophore," and whose artificial bird and flying screw have already been noticed.

The motive power in this aeroplane was, as in his former models, the force of twisted india-rubber threads, fastened to a stick 20 in. long, and rotating a double-vaned screw

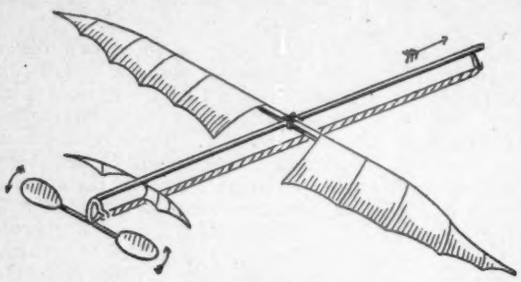


FIG. 53.—PÉNAUD—1871.

8 in. in diameter. The aeroplane, 18 in. across, by a width of 4 in., was fastened to the main stick at about its center, so that, through the leverage of the front end, the center of gravity of the apparatus should be slightly in front of the center of surface of the sustaining aeroplane. The outer ends of the latter were bent upward, so as to furnish lateral stability by a diedral angle, and the longitudinal stability was secured by fastening to the main stick, back of the aeroplane, as shown, a small pair of wings or rudders, set at an angle of about 8° pointing below the horizon of the main aeroplane.

This was the important feature of the apparatus, and M. *Pénaud* not only showed experimentally that it furnished automatic equilibrium, but he also demonstrated* the mathematical reasons why it should do so, in reestablishing, through the action of the air impinging upon this horizontal rudder set at a fixed angle, any deviation of the aeroplane from the horizontal line of flight. The principle is the same as that of the rear fold of the paper aeroplane which has already been described, and the following account of its mode of action was given by Mr. Bennett at the 1874 meeting of the Aeronautical Society of Great Britain:

> The center of gravity of the machine is placed a little in front of the center of pressure of the aeroplane, so that it tends to make the model descend an incline; but in so doing it lessens the angle of inclination of the aeroplane, and the speed is increased. At the same time the angle of the horizontal rudder is increased, and the pressure of the air on its upper surface causes it to descend; but as the machine tends to turn round its center of gravity, the front part is raised and brought back to the horizontal position. If, owing to the momentum gained during the descent, the machine still tends upward, the angle of the plane is increased, and the speed decreased. The angle of the rudder from the horizontal being reduced, it no longer receives the pressure of air on its superior surface, the weight in front reasserts its power, and the machine descends. Thus, by the alternate action of the weight in front and the rudder behind the plane, the equilibrium is maintained. The machine during flight, owing to the above causes, describes a series of ascents and descents after the manner of a sparrow.

The weight of the entire apparatus was 0.56 oz., of which the rubber absorbed 0.17 oz., or about one-third. The surface was 0.53 sq. ft., so that the proportion was nearly at the rate of 15 sq. ft. per pound, and necessarily gave a slow flight.

The apparatus was publicly exhibited in August, 1871, to a group of members of the French Society of Aerial Navigation, in the garden of the Tuileries, and the model, guided horizontally by a small vertical rudder, not shown on the figure, flew several times in a circle, falling gently to the ground near its starting-point, when the power of the rubber was exhausted. The speed was not quite 12 ft. per second, or about the same as that of insects with the same relative surface in proportion to their weight, and the flight was 131 ft. in 11 seconds, with 240 turns of the rubber.

Subsequently M. *Pénaud* measured the power consumed in a very ingenious way. He found that with 60 turns of the rubber the apparatus would just hold its own —*i.e.*, hover in the same spot, against a wind of 9 ft. per second, and knowing the speed of rotation of the screw, as well as the weight of the apparatus, he deduced the conclusion that the power expended was at the rate of one horse-power for each 81 lbs. of weight, although M. *Touche*, who has revised the calculations, makes it about three times this amount—a result, of course, quite inferior to those obtained by Professor Langley and by Mr. Maxim, because, perhaps, of the greater proportion of surface to weight.

M. *Pénaud* was a very ingenious man, and might have accomplished great things in aerial navigation had not his career been cut short prematurely. He was one of the few men who have taken up the subject in his youth, for it is a singular fact that most of the scientific students of this inchoate research are now men of middle age, perhaps past the dread of being considered mentally unsound, but no longer with the ardor and the daring of youth. M. *Pénaud*, however, began before he was 20 years old, by producing his flying screw. He had intended to enter the French Navy, but a painful hip disease had brought him to crutches, and left him no career but that of scientific studies. These he directed to aerial navigation, and during six or seven years of improved health he impetuously investigated and experimented upon the various phases of the problem. Not only did he produce the three forms of apparatus which have been described, almost the first which have practically worked, each flying upon a different principle and all produced by one man, but he took a very active part in the investigations promoted by the French Society for Aerial Navigation; making a scientific balloon ascent, in which he was somewhat injured, designing a plane table for platting the course of balloons, a guide rope break, a delicate barometer, a balloon-valve, a kite without a tail, balanced in the same way as his aeroplane, a form of explosion engine, a programme for experiments on air resistances, one for investigation of flight by instantaneous photography, since carried out by Professor Marey, etc., etc., towering above his fellow-members in discussions, in a way which must have excited many jealousies; and he also contributed a number of very valuable papers to the *Aéronaute*, in one of which he endeavored to account for the mystery of sailing flight by showing that ascending currents in the wind were not rare, and were quite sufficient to explain all the phenomena.

These labors finally culminated in his taking, in 1876 (in partnership with M. *Gauchot*, a clever mechanician, who had produced an artificial bird), a patent for the apparatus shown in fig. 54, which was to be of sufficient size to carry up two men.

It was to consist of an aeroplane somewhat in the form of an ellipse, built of a light framework covered both at top and bottom with varnished silk, and stiffened by wire stays radiating from two short masts above and from the car below the aeroplane. The outer ends of the aeroplane were to be flexible, or to be set at a diedral angle, in order to produce lateral stability, and the rear portion was also to be flexible and to bend upward, to produce the longitudinal stability, this being, moreover, provided for by two horizontal rudders, side by side, hinged at the rear, so as to set themselves automatically at the angle required to produce fore-and-aft equilibrium, upon the principle developed in the "planophore." Under these balanced horizontal rudders a vertical rudder was to steer to the right or left. A car, in the shape of a light boat, was to be rigidly attached just under the aeroplane, the steersman standing or sitting at the bow, with his head just above the top of the aeroplane, and protected from the

* *Aéronaute*, January, 1872. Page 4.

wind by a glass box. Movable legs with rollers and springs were to be let down to get a preliminary run on land, or to alight in a glancing direction.

The motion was to be obtained from two propellers, placed at the front edge of the aeroplane, and rotating in opposite directions; the power to be furnished by a steam-engine—although M. *Pénaud* said frankly that he knew of none in practical operation sufficiently light for his purpose. He believed it ought not to weigh more than 15 to 22 lbs. per horse-power, and hoped to get one constructed within those limits. The engine was so to be located in

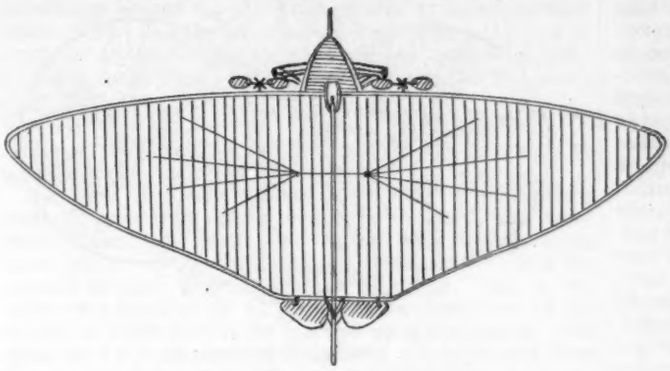


FIG. 54.—PÉNAUD & GAUCHOT—1876.

the car as to bring the center of gravity of the apparatus one-fifth of the distance back of the front edge, and all the steering was to be done by the helmsman through a single lever, which might either be pulled or pushed to work the horizontal rudders, or twisted to work the vertical rudder.

The sustaining surface of the aeroplane was to be proportioned at the rate of about 0.24 sq. ft. per pound of weight, the whole apparatus with two aviators was to weigh 2,640 lbs., and required an engine of 20 to 30 H.P. to fly through the air at 60 miles per hour, with an angle of incidence of 2°.

This apparatus, the result of several years of study by an able man who bestowed very careful thought thereon, was never built. The writer of this does not believe it would have succeeded if it had been experimented with, but valuable data might have been obtained. Aside from the difficulty about a light motive power, a difficulty now almost removed, it may be questioned whether the general form of the aeroplane was the best possible to glide upon the air, and whether the longitudinal equilibrium would have been as well preserved as in M. *Pénaud's* toy model. If not, then a sustaining surface of only 0.24 sq. ft. per pound would have been exceedingly dangerous. The horizontal rudders, when left to adjust themselves, were expected to regulate the automatic balance, but they were also expected, when actuated by the steersman, to alter the angle of incidence, in order to cause the apparatus to rise or to fall. Such a change in the angle would necessarily alter the position of the center of pressure, and there was no provision for making a corresponding change in the center of gravity, other than by the displacement of the aviators themselves, or that of the fuel, water, or boiler, which displacement would be nearly impracticable. This was the weak point, for the pressure being then applied at a point differing from the center of gravity, would act with a leverage upon the apparatus and tilt it either forward or backward longitudinally, so that, had it been experimented with on a practical scale, it might have experienced a forward sheer or a plunge, either from too great an action of the horizontal rudders in rising or in coming down, or, as in the case of poor *Le Bris's* second experiment, from encounter with a stratum of wind of different horizontal direction than that for which the machine was adjusted.

Perhaps surmising the possibility of some such action, M. *Pénaud* suggested that the experiments should be conducted over a sheet of water. The apparatus might also have been suspended between two very high masts, or from a captive balloon, but probably the best results would have been obtained by experimenting entirely clear of any restraining supports.

At any rate no funds were forthcoming for the construction of the full-sized machine. M. *Pénaud* was criticised, decried, misrepresented, and all sorts of obstacles arose to prevent the testing of his project. He lost courage and hope, his health gave way, and he died in October, 1880, before he had reached 30 years of age.

He had doubtless done much toward solving the difficult problem of automatic stability in the air, but the French aviators do not seem to accept M. *Pénaud's* device as a solution of the question of longitudinal equilibrium. They claim that it consumes too much power in the constant readjustment of the stability, and that in a full-sized navigable apparatus it would not act quickly enough to prevent disaster. In September, 1890, M. *Hureau de Villeneuve* published a paper in the *Aéronaute*, in which he treats the problem of stability as yet to be solved, and suggests the inverted cone, as exemplified in the parachute of Cocking (which failed simply by reason of faulty construction), and he proposes as a possible solution of the equilibrium in both directions, that the aviating surface shall be made to conform to the development of an inverted cone. That is to say, that its lines, whatever they may be in the ground plan, shall in vertical projection follow the development of an inverted cone, placing the center of gravity so as to correspond with the position of the apex, and this he seems to have illustrated with a number of working models by cutting out various forms of birds out of an inverted cone.

Pénaud said that his solution was practically the same as that of Sir *George Cayley*, with whose labors he was not acquainted at the time that he hit upon the device for his "planophore." In his articles in *Nicholson's Journal*, published in 1809 and 1810, Sir *George Cayley* shows that the lateral stability is easily secured by placing the wings, either curved or plane, at a slight diedral angle to each other, and he lays down the principle, that in order to secure the longitudinal stability: 1. The center of gravity must be made to occupy a position directly under the center of pressure; and 2. The aeroplane requires, to steady it, a rudder in a similar position to the tail in the bird. He then continues:

> All these principles upon which the support, steadiness, elevation, depression, and steerage of vessels for aerial navigation depend have been abundantly verified by experiments, both upon a large and small scale. I made a machine having a surface of 300 sq. ft., which was accidentally broken before there was an opportunity of trying the effect of the propelling apparatus, but its steerage and steadiness were perfectly proved, and it would sail obliquely downward in any direction according to the set of the rudder. Its weight was 56 lbs., and it was loaded with 84 lbs., thus making a total of 140 lbs., or about 2 sq. ft. to 1 lb. Even in this state, when any person ran forward in it with his full speed, taking advantage of a gentle breeze in front, it would bear upward so strongly as scarcely to allow him to touch the ground, and would frequently lift him up and convey him several yards together. . . . It was beautiful to see this noble white bird sail majestically from the top of a hill to any given point of the plain below it, with perfect steadiness and safety, according to the set of its rudder, merely by its own weight, descending in an angle of about 8° with the horizon.

A number of very interesting experiments upon the stability of aeroplanes were tried in 1873 and 1874 by Mr. *D. S. Brown*. He had begun by seeking for a light motive power, and his proposal for a steam-engine with an india-rubber bag instead of a cylinder has already been noticed; but becoming aware of the enormous importance of stable equilibrium, he turned his attention in that direction. He exhibited at the meeting of the Aeronautical Society of Great Britain, in 1873, a model consisting of two planes of equal size, one placed before the other at some distance and connected by a rod, which arrangement showed much greater stability than a single plane, and he followed this up at the next meeting, in 1874, by exhibiting models of what he called his "aero-bi-plane," which showed still further improvement in the stability, in consequence of

"constructing the anterior edges or frames of the planes rigid, and the other parts yielding or elastic." The two planes might be rectangular and have their anterior edges straight, or these might be curved to diminish the air resistance, and the surfaces were placed one behind the other in the same general plane, so that they did not, as in the case of *Pénaud's* "planophore," make a slight horizontal angle with each other.

Mr. *Brown* stated that "the aeroplane should not be inclined to its path of motion, but its surface should form a direct line with it. . . . the plane being kept at the same elevation by slightly directing its course upward, sufficient to compensate for any fall which may take place." As, however, there was in the model a horizontal rudder, which regulated the angle of incidence in flight, Mr. *Moy* pointed out that the claim was a distinction without a difference. In one model the planes were connected with each other through double rods, so as to admit of a load, representing a car, being placed between them, and Mr. *Brown* stated that in this form it might be termed a progressive parachute, which was only supported by the air when in forward motion. When this motion was stopped—and this might be done by bringing it suddenly into a large angle with the horizon, so as to increase the resisting surface—the model settled down to the floor. It being, therefore, necessary that the apparatus should start with an initial motion, this was given by an india-rubber rope fastened at one end to a post, and at the other, by means of a ring, to a vertical bolt inserted in the under part of the bi-plane, so that it might be released when the rope slackened. The experiments are described in the report of the meeting as follows:

Mr. *Brown* launched several planes of different dimensions. All showed perfect stability, and, save one or two, floated in the air in a horizontal position across the room, a distance of between 20 and 30 ft., and, apparently, in some instances could have gone further without falling had not the walls intervened. One he suddenly pressed downward in a perpendicular direction by striking it with a stick when in the air; this caused it to dart forward with great velocity in a horizontal course. Mr. *Brown* considered this an illustration of true flight, as the planes were only inclined the moment he struck the connecting-rod. During the flight they recovered their horizontal position and offered no resistance to the air.

It may be noticed that this arrangement of surfaces, which Mr. *Brown* referred to as "first steps to flight," differs from that of M. *Pénaud* in making the rear plane of the same size as that of the front, and parallel therewith, the automatic stability being obtained through the flexibility of the posterior edge, which acts much in the same way as the upward inclination of the rear plane or rudder in *Pénaud's* apparatus. Whether either of these arrangements, thus slightly differing in construction, will prove adequate in practical operation upon a large scale, can only be ascertained by experiment, but it may be stated that the British aviators have not accepted Mr. *Brown's* proposal as a solution of the problem of equilibrium, and that some of them believe that he made a mistake in placing his planes parallel with each other; "no change of action taking place whether the planes move from the horizontal to 45° or to any other angle."

The next apparatus to be noticed will be found described in most of the articles on flight in magazines and in encyclopædias, but the writer of these lines has been fortunate enough to obtain from Mr. *Moy* himself still further particulars concerning an experiment which has well been characterized in the reports of the Aeronautical Society of Great Britain as "one of the most determined attempts at solving the problem which has yet taken place."

Fig. 55 shows a front view, from a photograph, of "Thomas Moy's aerial steamer," which was tried in the open air at the Crystal Palace near London in June, 1875. The supporting surfaces consisted in two aeroplanes, one in front and the other behind the propelling aerial wheels; the planes being of linen, stretched upon bamboo canes, and set at an angle of 10° with the horizon, the rear plane being placed higher than the front plane, but parallel therewith. A third steering plane, of smaller size, governed by a horizontal wind wheel with screw vanes, was placed in the rear to serve as a horizontal rudder. The front plane measured 50 sq. ft., and the after plane had 64 sq. ft. of surface; their true size in relation to the whole apparatus being inadequately shown in the figure, because of the perspective, as they are seen nearly edgewise.

Between the two supporting aeroplanes were placed two propelling aerial wheels 6 ft. in diameter, each provided with six blades. These were first made of thin laths to approximate to true helices, but were afterward made of Scotch cambric. The blades or vanes were by a most

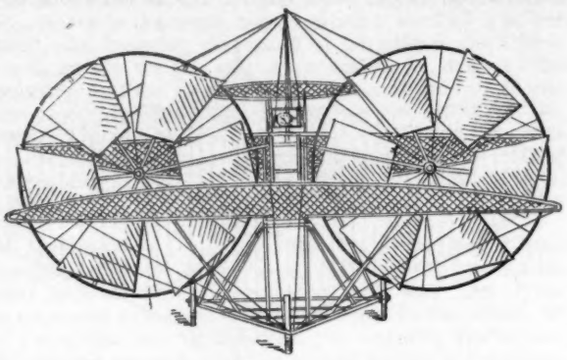


FIG. 55.—MOY—1875.

ingenious and simple arrangement caused to change their angle of incidence as they rotated, so as to be "successively caused to be inclined to the line of onward motion of the machine, in such a manner that the blades on one side of the neutral line will be caused to act downward on the air with both a raising and propelling effect, while those on the other side thereof will, in their upward course, be impinged upon by the air with only a lifting tendency." This being in effect an aerial screw in which the pitch was variable in every portion of the revolution, and constituting the chief feature of novelty in the whole apparatus.

The steam-engine was placed between the two aerial wheels, and was a marvel of lightness. The diameter of the cylinder was 2½ in. and the stroke 3 in., with 520 to 550 revolutions per minute. The heating surface was 8 sq. ft. or 2⅝ sq. ft. per horse-power, the boiler being of the water-tube description, and the steam pressure was 120 to 160 lbs. per square inch, the fuel being liquid and burned in Russian lamps. The engine weighed, with the boiler, 80 lbs. and developed fully 3 H.P., being at the rate of 26⅔ lbs. per horse-power, or about the same as the 1868 engine of Mr. *Stringfellow* as rated by himself. Mr. *Shill*, a clever mechanician, who exhibited a remarkably light engine in 1868, was associated with Mr. *Moy* in producing the 1875 engine, and had an interest in the patents, so that the apparatus was also known as the "Moy & Shill aerial steamer." It was 14 ft. long and about 14 ft. wide, was mounted on three wheels, and weighed 216 lbs., thus being proportioned at the rate of 0.53 sq. ft. of sustaining surface per pound of weight, omitting the lifting effect of the aerial wheels, which measured 60 sq. ft. more.

The inventor estimated that at a speed of 35 miles per hour the apparatus would be able to rise from the ground and glide upon the air, and this estimate seems fully confirmed by Professor Langley's recent experiments, which show that the uplift on a plane surface of 114 sq. ft. at an angle of 10° would be fully 206 lbs., while somewhat higher results are obtained from the table of "lift" and "drift" heretofore given herein, when taken in connection with Smeaton's table of wind pressures.

After some preliminary tests a path around one of the fountains at the Crystal Palace was selected, which had a diameter of nearly 300 ft.; a pole was erected at the center of the fountain, and two cords were run from the top of the pole to each end of the machine, in order to keep it at a uniform distance from the center. The gravel had been rolled, and steam was got up. The gravel, however, proved too rough, it shook the steamer and largely increased the traction. Then a board walk was laid over

the path, and again steam was got up and a good run was made around the fountain, the machine (which was only a large model and could not carry an engineer) being wholly propelled by the action of the aerial wheels upon the air, acting only as drivers.

The utmost speed attained was 12 miles per hour, while 35 miles an hour was required to cause it to leave the ground. This indicated that the resistances had been underestimated, which resistances consisted in the traction upon the boards, the air resistance on the framing, cordage and ground wheels, and also in the "drift" due to the inclination of the sustaining planes. With our present knowledge we can say that at a speed of 35 miles per hour (6 lbs. per sq. ft.) the latter would have been: $114 \times 6 \times 0.0585 = 40$ lbs., and as the speed would have been 3,080 ft. per minute, the power required by the "drift" was: $\frac{40 \times 3080}{33.000} = 3.73$ H.P., to say nothing of the other elements of resistance, so that it is not strange that only 12 miles an hour was attained.

Mr. *Moy* needlessly handicapped himself in starting from the ground by a level run. He reasoned, like many others before and since, that "when they were coming down power was wanted, and, of course, power was especially wanted when they were going up," but he encountered thereby, in an experimental machine, all the additional resistance of the traction upon the boards. He considered the propriety of launching the apparatus from a height, or down an incline, but then this costly machine, built wholly at his own expense, would surely have come to grief, for he says that "the transverse stability was better than the longitudinal stability, but both were bad," and unless this was first remedied, it really was not safe to experiment.

Mr. *Moy* also placed his sustaining aeroplanes at too obtuse an angle, for if he had simply doubled their area, and inclined them at 5° instead of 10°, the "lift" would have been, by the table, at 35 miles per hour: $228 \times 6 \times 0.173 = 236$ lbs., or practically the same as before, but the "drift" would have been diminished to: $228 \times 6 \times 0.0152 = 20.79$ lbs., or about one half of that heretofore calculated.

Such experiments would doubtless have been tried had ample means been forthcoming, but other things were more pressing, for it was recognized that some modifications would be required in the steam generator, which was provided with six Russian lamps burning methylated spirits, and it was found that when running in the open air, the fumes from the three forward lamps extinguished the three after lamps, and thus reduced the power one-half. Before even this difficulty could be remedied the machine was seriously injured by the wrecking of the bamboo aeroplane frames, while it was being moved *stern first* across the grounds, in a fierce gale, and Mr. *Moy* then decided to rearrange it for experiment, as to its vertical lifting power, by substituting 12-ft. aerial wheels with vertical axles tried under cover.

The total surface of these new aerial wheels was 160 sq. ft., and the weight, including engine, boiler and all accessories, was 186 lbs. It was found that by counter-balancing 66 lbs. with levers, the wheels would lift the remaining 120 lbs., thus showing a lift of 40 lbs. per H.P., or about the same as the best performance which has been attained with other forms of screws.

Mr. *Moy*, as the result of his various experiments, then proposed to build a much larger apparatus, with an engine of 100 H.P., and capable of carrying several men, both to avail of the diminished relative weight and resistance of larger engines and to secure intelligent control while in action; but the money could not be secured for this purpose. It would necessarily have cost a large sum, and at that time (1875) not only was the whole subject of aerial navigation generally considered as visionary, but there was not sufficient knowledge to enable the public, or even scientific men, to distinguish the difference between a wild proposal, sure to fail to compass flight, and a promising experiment which was worth following up—a condition of affairs which has in a measure continued to this day, and which this account of "Progress in Flying Machines" is partly written to remedy.

So Mr. *Moy* got no money, but he had instead "two chancery suits about shares in his patents, with no help from any one;" his experiments had brought him down in funds, and he had to turn to hard work to live. As he justly remarks, "Unless you can lift the last ounce of a model, the unscientific people call it a failure, and few can appreciate that as size and weight increase, the relative hull resistance decreases, by reason of its diminished surface in proportion to its cubic contents." He, however, continued to take an active interest in the subject; read papers at the meetings of the Aeronautical Society of Great Britain, made private experiments with planes, both in air and in water, as well as with methods for securing automatic stability, and with an improved method of propulsion.

In 1879 Mr. *Moy* exhibited at the meeting of the Aeronautical Society the small flying model shown in fig. 56, which he described as a "military kite" mounted upon wheels and provided with propelling gear. The front plane measured 660 sq. in. of surface, and the after plane, of

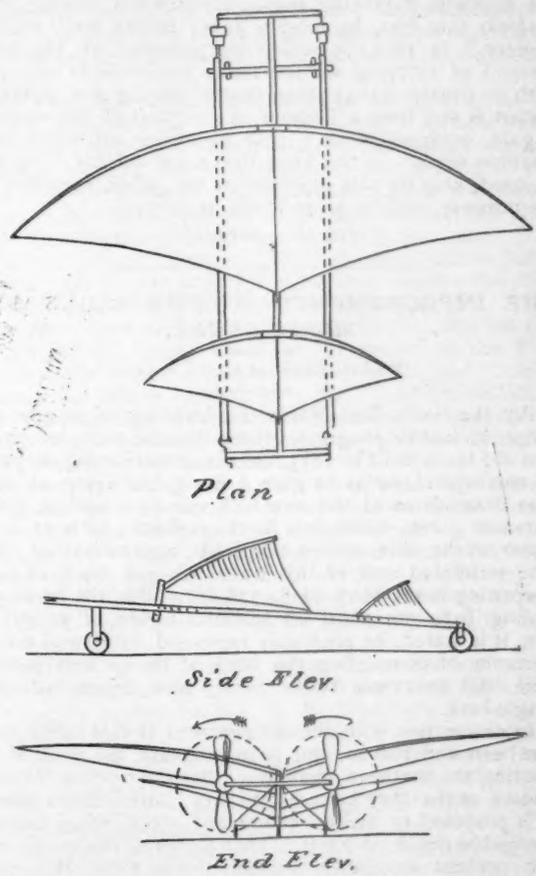


FIG. 56.—MOY—1879.

half its linear dimensions, measured 165 sq. in. They were made of cambric, fastened to a central box-girder of thin pine, running lengthways, and mounted on small wheels, the aeroplanes being given a diedral angle, as shown, and the angle of incidence fore and aft being adjustable. At each end of the central stick or box-girder cross-arms were fastened, which held in position strands of india-rubber strings, one on each side of the central stick and parallel therewith, the untwisting of which rotated (in opposite directions) two screw propellers with two vanes each. These propellers are removed in the plan and side view of fig. 56, for the sake of clearness, but are shown in the end elevation or front view.

The model weighed 24 oz., of which 3½ oz. was in the india-rubber springs, and with 500 turns of the rubber it would run on its wheels over a smooth surface, and under favorable circumstances would rise for a short distance upon the air. It would, of course, fly from the hand like

Pénaud's planophore, but showed, like it, great waste of power, the supporting surfaces being at the rate of 3.82 sq. ft. per pound, and the angle of incidence required for it to rise from the ground being 8° ; and more unfavorable than a flatter angle, at which, however, it would not have possessed sufficient "lift." Mr. *Moy* says that "its transverse stability was very good, but its longitudinal stability was defective, and was a perfect puzzle at that time, but now all these troubles are overcome."

He has recently patented in England a method for automatically securing horizontal stability, and it is to be hoped that he will be enabled to renew his experiments.

Mr. *Moy* has also been an observer of soaring or "sailing" flight, and he described the sailing of the albatross in a wind, on rigid wings, in a paper read before the Aeronautical Society in 1869. Deeming it possible for man to imitate this performance, but recognizing the prodigious difficulty of reproducing the complicated shape and arrangement of curved surfaces (not planes), with which impulse is received from the wind, and of imitating the exquisite balancing through which the soaring birds perform this feat, he read a paper before the "Balloon Society," in 1884, in which he proposed an ingenious method of carrying on the many experiments required, with no greater danger than that of getting wet, by taking a start at sea from a lifeboat on the crest of the waves in a gale, equipped with a pair of wings and an inflated Boynton dress. In the hope that some aviator, favorably situated, may try this experiment, the paper, rewritten for the purpose, will be given in the appendix.

(TO BE CONTINUED.)

THE IMPROVEMENTS OF THE SAULT STE. MARIE CANAL.

(From the Cleveland *Marine Record.*)

AT the Sault Ste. Marie the building of a new and larger lock is in progress, taking the site occupied by the two old locks built in 1855, the canal itself being deepened to correspond, so as to give a navigable depth of 20 ft. The dimensions of the new lock will be: Length 800 ft. between gates, width 100 ft. throughout, with 21 ft. of water on the sills, with a single lift, approximating 18 ft. The estimated cost of this new lock and work of canal deepening is set down at $4,738,865. For the fiscal year ending June 30, 1893, an additional sum of $2,000,000 can, it is stated, be profitably expended, in view of the importance of completing the work at the earliest possible date, the enormous traffic being now dependent on a single lock.

In connection with the enlargement of this canal, there has been undertaken, and is in progress, the work of improving the southern channel of the river below the falls, known as the Hay Lake Channel in United States waters. It is proposed to make a channel of 300 ft. wide, and of a navigable depth of 20 ft. The improved route will leave the present navigable channel of the river at a point Sugar Island Rapids, about 2½ miles below the canal; will pass through these into Hay Lake; then by way of Middle Neebish; rejoining the present navigable channel at the foot of Sugar Island; saving a distance of 11 miles (16 miles in place of 27), and giving a route which can be so marked by lights as to be navigable at night, an advantage which is not to be afforded by the present channel, except by the use of many lights. The estimated cost of the work is set down in the report of the U. S. Engineers at $2,659,115.

The Dominion Government has also entered into the construction of a large canal, and it is being rapidly constructed through St. Mary's Island, on the north side of the rapids. At ordinary stages of the river water, there is a difference of 18 ft. in the levels of the water above and below this island. The length of the canal across the island is 3,500 ft. A considerable amount of excavation is required to form channels of approach, both at the upper and at the lower entrances. The total length of this canal and its approaches will be about 18,100 ft. The plans for the Dominion canal lock, after several modifications and radical changes, are as follows: Length of chamber, 900 ft.; width of chamber, 60 ft.; gate width 60 ft.; depth of water on the sills, 19 ft. at the lowest recorded water level. This depth, though calculated on a different basis (extreme low instead of mean water level), is intended to be the equivalent of the depth, 21 ft., of the new American lock now under construction. By the scheme as modified, accommodation will be afforded to three vessels lying in the lock, one behind the other, one of the lake type 320 ft. long, and two of the Welland Canal type, 255 ft. long, with ready means of entrance and exit on a course through the gates and lock straight with the line of the canal. The canal proper will have a width at low water level of 152 ft., and a bottom width of 145 ft. The depth will be made suitable to navigation at mean water level by vessels drawing 20 ft., and the gates will be worked either by hydraulic power or by electricity.

THE LOCOMOTIVE PROBLEM AGAIN.

IN the RAILROAD AND ENGINEERING JOURNAL for April last there was given the following

PROBLEM.

Let it be supposed that the stroke of the pistons of a locomotive is 2 ft., the diameter of the driving-wheels 7 ft. and the speed 60 miles per hour; what is the maximum and minimum velocity of the piston relatively to the earth, and not with regard to the locomotive, and when does each occur?

Several answers were received to this and were published in the July, August and October numbers of the JOURNAL; since then some additional replies have been sent in, which are given below:

VIII.—BY D. E. HUGHES, C.E., IRVINGTON, CAL.

My solution of the Problem is as follows (see fig. 6):

$$b = \sqrt{c^2 - r^2 \sin.^2\theta} + r \cos.\theta$$

$$\frac{\text{velocity cross-head}}{\text{velocity crank-pin}} = \frac{db}{r\,d\theta} = \frac{\sin.\theta \cos.\theta}{\sqrt{\frac{c^2}{r^2} - \sin.^2\theta.}} + \sin.\theta \quad (1)$$

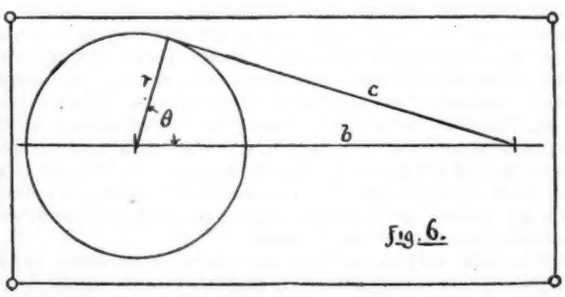


Fig. 6.

To find where this ratio is maximum, put the first derivative of (1) equal to zero, and solve for θ.

$$\frac{\sqrt{\frac{c^2}{r^2} - \sin.^2\theta}(\cos.^2\theta - \sin.^2\theta) + \frac{\sin.^2\theta \cos.^2\theta}{\sqrt{\frac{c^2}{r^2} - \sin.^2\theta}}}{\frac{c^2}{r^2} - \sin.^2\theta} + \cos.\theta = 0. \quad (2)$$

Reducing (2),

$$\cos.^6\theta + \left(\frac{c^2}{r} - 3\right)\cos.^4\theta - \left(\frac{c^2}{r^2} + 3\right)\left(\frac{c^2}{r^2} - 1\right) = 0,$$

$$\cos.^2\theta + \left(\frac{c^2}{r^2} - 1\right) = 0. \quad (3)$$

If $r = 1$ and $c = 8$, (3) becomes—

$$\cos.^6\theta + 61\cos.^4\theta - 4221\cos.^2\theta + 63 = 0,$$

whence $\theta = 82° 58' 55''$.

Substituting this in (1) gives ratio = 1.007784.

Then maximum vel. piston = 60
+ 1.007784 times $\frac{2}{7}$ of 60 = 77.276297
and minimum vel. piston = 60
− 1.007784 times $\frac{2}{7}$ of 60 = 42.723703
If $c = 3$ ft. equation (3) becomes,
$$cos.^6\theta + 6\,cos.^4\theta - 96\,cos.^2\theta + 8 = 0,$$
whence $\theta = 73°\ 10'\ 31''$
and ratio = 1.054639,
giving max. vel. of 60
+ 1.054639 times $\frac{2}{7}$ of 60 = 78.079526 mi. pr. hr.
and min. vel. of 60
− 1.054639 times $\frac{2}{7}$ of 60 = 41.920474 " " "

In both of these cases θ is greater than the angle to the point where the connecting-rod is tangent to the circle; in the first by 0° 6′ 25″; in the second, 1° 38′ 37″. The ratio at the point of tangency in the second case is 1.054092.

It is assumed in the foregoing that the piston travels horizontally and on a level with center of drive-wheel.

Since writing the above I have used $r = 1$ and $c = 2$, obtaining $\theta = 67°\ 42'\ 00''$, which is 4° 15′ 54″ from point of tangency, and ratio = 1.123208. As a check on the figures, and more particularly to guard against an oversight in my equations, I plotted this last to a large scale with great care. This gave the same results, as close as plotting could indicate.

A little investigation will show that the connecting-rod cannot have such length as will make maximum velocity of piston occur when connecting-rod is tangent to the crank-pin circle.

You will notice that No. 4's result agrees with mine for two decimals. He makes $u = 25.33$, while mine, reduced, is 25.33857.

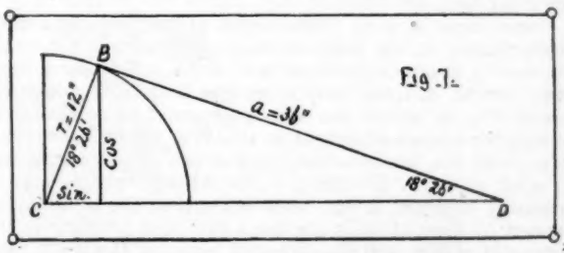
The discrepancy would be greater with a shorter connecting-rod.

IX.—BY SETH PRATT, C.E., ASSYRIA, MICH.

By calculation it is found that the maximum motion of the piston is when the connecting-rod is tangent to the radius of the crank-pin circle.

$$tan.\ B\,D\,C = \frac{r}{a} = tan.\ 18°\ 26' + = C\,B\,E.\quad \text{(See fig. 7.)}$$

Assuming the angle $C\,B\,E = 18°\ 25'$ and 18° 27′ and computing the distances $C\,D$ upon these assumptions, and



taking their *difference*, we get the motion for 2′ of that of the wheel.

Now, by the

1st. $\begin{cases} r\ sin.\ 18°\ 25' = .3159250 \times 12 = 3.7911000 = C\,E. \\ r\ cos.\ 18°\ 25' = .9487842 \times 12 = 11.3854104 = B\,E. \end{cases}$

2d. $\begin{cases} r\ sin.\ 18°\ 27' = .3164770 \times 12 = 3.7977240 = C\,E. \\ r\ cos.\ 18°\ 27' = .9486002 \times 12 = 11.3832024 = B\,E. \end{cases}$

$\sqrt{a^2 - B\,E^2} + C\,E = 37.9432951$. By the 1st.
$\sqrt{a^2 - B\,E^2} + C\,E = 37.9506551$. By the 2d.

Difference = .00736 = motion for 2′,
or 30 × .00736 = .2208 in. = motion for 1°.
Since there are four revolutions per second, we have

$$\frac{.2208 \times 4 \times 360° \times 3600^s}{12 \times 5280} = 18.06\tfrac{5}{11} \text{ miles per hour.}$$

$60 + 18.06\frac{5}{11} = 78.06\frac{5}{11}$ miles per hour = maximum motion
$60 - 18.06\frac{5}{11} = 41.93\frac{6}{11}$ " " " = minimum motion.

The solutions received have presented the problem in different lights; perhaps our readers can judge whether any of them are entirely correct.

IRRIGATION IN INDIA.

(Translated from *Mémoire* by Chief Engineer Barois, in *Les Annales des Ponts et Chaussées.*)

I.—INTRODUCTION.

ENGLISH INDIA is certainly the country in which engineers have executed the most numerous and important irrigation works. Dams across the largest rivers, canals several hundred miles in length, carrying to the farmer at all seasons the water necessary to the development of his crops; inundation canals fertilizing the soil during floods; reservoirs of all sizes storing up the water during the rainy season to distribute it in time of drought; works of every kind for watering the high valleys among the hills and the lowlands of the deltas—such form the magnificent system which has been created to protect agriculture against the vicissitudes of climate, and to increase the production of the soil.

This system, which includes some works of great antiquity, extends from the foot-hills of the Himalaya Range to the southern point of India, under widely differing conditions. Among the more important works are:

In the Indus Basin the Bari-Doab Canal, the Sirhind Canal, and other canals fed by the Sutlej River; the overflow canals leading from the Indus itself, etc., etc.

In the Ganges Basin the Western and Eastern Jumna canals; the Upper and Lower Ganges canals; the Agra Canal; the Soane River Canal, and others.

In the valleys of the various rivers flowing into the Gulf of Bengal the Orissa Canal at the mouth of the River Mahanuddy; the Godavery Delta Canal; the Cauvery Canal; the Kistna Delta Canal; the Upper Kistna Canal; the vast reservoirs of Ekruk and Mutha on the upper tributaries of the Kistna; the Chembrambankam Reservoir near Madras and many others.

A complete and detailed study of all these works would be almost an encyclopædia of information for the use of engineers who have to plan irrigation works. No such book exists, and only descriptions of certain works can be found in the papers issued from time to time by the Thomasson College of Engineering at Roorkee, or in an occasional paper read before the Institution of Civil Engineers at London.

In preparing the present paper the writer has been to some extent aided by the Roorkee Treatise on Civil Engineering in India; by Mr. R. B. Buckley's book on the Irrigation Works of India and their Financial Results; and by several official reports; he is also indebted to Sir Colin Scott Moncrieff, now Secretary to the Ministry of Public Works at Cairo, Egypt, who formerly had the direction of important works in India.

The object of the paper is to give a general idea of what irrigation is in India, and to point out some of the principal works of that kind in the country. It can be only a brief summary, a sort of table of contents, incomplete in itself and serving simply to point the way to more profound studies of this great subject.

II.—GENERAL CONSIDERATIONS.

The conditions of climate in India are such that, with a sufficient supply of water, the land can usually be cultivated the entire year and two crops can be gathered. In the spring grain and other products of a temperate climate; in autumn tropical crops such as rice, cotton, maize,* sugar-cane and indigo.

The *régime* of the rivers, and in consequence the method of cultivation, differs widely in different provinces.

In Northern India the great rivers which descend from the Himalaya Region have their lowest waters in winter. The melting of the mountain snows feeds them from March to May; they are generally highest under the action of

* In France corn is generally considered a tropical product, and M. Barois does not seem to know that in America corn is grown successfully much further north than is supposed possible in Europe.

the heavy and almost continuous rains which fall during the *monsoons* from June to September, and after that month they fall rapidly.

In this region the spring crops—called *Rabi*—have special need of irrigation in February and March, when they are coming to maturity and when the rivers are lowest. The autumn crops—the *Kharif*—which are partly watered by the rains, are in hand while the rivers are high, and need water at different times; sugar-cane and indigo chiefly in May and June, and most of the others in September and October, at the time when the farmers begin to plow the ground for the grain crops which grow during the winter.

In years when the rainfall is normal cotton and maize do not need irrigation.

The chief crops are those of spring, the extension of which is limited as much by the supply of water which can be drawn from the rivers as by the extent of land which can be irrigated. These are considered very important, since among them is the wheat which India has been of late years exporting in large quantity, becoming a competitor with Russia and America in the markets of the world.

In Lower Bengal rice is the leading crop, and it receives its irrigation during the season of the floods.

In Central and Southern India the rainy season is short; moreover, the large water-courses, not being fed by mountain snows, have a very restricted flow from April to July; they begin to rise with the monsoon. The most general crop is rice, which grows almost entirely during the wet season, from June to November. Along the rivers the extension of this culture is limited rather by the amount of land which can be irrigated than by the supply of water, which is always sufficient. In the districts away from the large rivers the rain-water flows off too quickly to permit of the cultivation of rice, unless the rainfall is secured and held in reserve in storage reservoirs.

In these southern provinces the winter crops are less important, especially as very little wheat can be grown there.

According to locality, to the abundance or scarcity of rainfall, and to the sources from which the rivers are fed, the utilization of water for agricultural purposes is practised in India in four different ways:

1. By *irrigation canals*, which carry water to the land, either during the whole year or for a part only.

2. By *overflow* or *inundation canals*, which water the autumn crops during the season of floods in the rivers, and which also, before the rivers fall, serve also to irrigate the land prepared for the second or spring crop.

3. By *reservoirs* collecting the waters during the monsoon and storing them up for distribution during the dry season.

4. Lastly, by *wells* dug in the alluvial soil of the valleys and receiving the waters of infiltration. These are largely used to supplement the usual sources of irrigation, when the latter prove insufficient.

The system of inundation canals is especially developed in the Punjâb and throughout the Indus Valley. The reservoir system finds its greatest development in the Presidency of Madras and in Southern India.

The quantity of water needed in the several provinces differs according to the soil, the climate, and the nature of the crops. The duty of the canals depends upon the amount required, and is more difficult to calculate in the northern provinces, owing to the greater variety of crops cultivated there. In the southern provinces, where rice is the dominant crop—almost the only one, in fact—the problem is a very simple one to solve.

A continuous delivery of 9 cub. in. per second on the Ganges Canal, or of 8 cub. in. per second on the Eastern Jumna Canal, is sufficient on the average to irrigate an acre of land. Assuming that for each acre irrigated by a canal there are two acres either not under cultivation or watered by rain or from wells, there would be required an average duty of from 2.67 to 3 cub. in. per second per acre of cultivable land. This proportion differs widely, however, in different localities. For instance, in several districts supplied from the Eastern Jumna Canal the land irrigated each year is from 70 to 80 per cent. of all the cultivable land.

On the Soane Canal an acre under summer culture requires a delivery of 21.5 cub. in. per second; under winter culture this falls to 9.2 cub. in.

In the latest plans for canals in Northern India, it is calculated that from 17 to 30 cub. in. per second are needed for each acre for summer crops, and from 10 to 12.5 cub. in. for winter crops.

The relative proportion of these crops is very variable. Along the Jumna they occupy almost equal areas. In the Northwest Provinces the surface cultivated in summer is, on an average, about 60 per cent. of the land under crops during the winter.

At Tanjore it is estimated that a delivery of 43 cub. in. per second per acre is needed for a rice-field.

In the Presidency of Madras, in calculating the capacity of reservoirs, it is assumed that 3 cub. ft. of water are needed for the continuous irrigation of 1 sq. ft. of land for the entire year. It is, moreover, estimated that a rice-field ought to be covered with water to a depth of 5 in. for 72 days—that is, for 1 acre of rice it is necessary to be able to deliver about 133,000 cub. ft. of water in 72 days. This, with the losses due to evaporation—which may easily rise to about 6½ ft. in depth in a year in that climate—makes the amount of water which must be stored during the rainy season about 494,000 cub. ft. per acre.

All these figures show that it is only by a very careful study of the needs of agriculture in each district that the proper dimensions of irrigation works can be determined.

III.—DAMS.

The English engineers have had to build on many of the great rivers of India, at the head of irrigation canals, large dams intended to retain the water during the season of low water, and to permit the use of the entire flow when needed.

In these works they have generally sought simplicity of construction and easy maintenance and management.

Thus, they have adopted as much as possible fixed dams; they leave only some openings with movable gates to permit the escape of superfluous water, and they provide weirs to prevent the accumulation of deposits about the canal heads. Moreover, where they have found it difficult to reach bed-rock they have usually contented themselves by making for foundations brick-lined wells filled with concrete; these wells are sunk to a greater or less depth in the mud, the sand or the gravel forming the river-bed.

Some dams have no foundations at all, but are simply walls resting on the river-bed and protected against washing out by heavy embankments of stone. This plan, however, can be adopted only when the bottom is not easily permeable, or where the supply of water is so abundant during the season of irrigation that it is not indispensable to prevent the losses which may result from infiltration. In other cases, in Northern India, where there is need of economy in water, it has been found that the foundations formed by lines of wells are not a sufficient obstacle to the escape of water, and the intervals between the wells have been filled by masonry walls.

The conditions of execution of these fixed dams, founded at slight depth upon permeable soils, have required the use of great masses of rock filling, or backing, intended not only to counteract the pressure of the water, but to support the dam under the serious strains caused by the flow over the crest during floods.

The water-courses on which dams have been built in India may be classed under six heads, as below:

1. The river-bed is of rock, or of rock mixed with solid earth or stiff clay; the fall is about 1 in 1,000.

2. The river-bed is a comparatively thin layer of sand resting on clay; the fall is less than 1 in 1,000.

3. The river-bed is of sand and large gravel, mixed with pebbles; the fall is 1 in 2,000.

4. The river-bed is formed, to a great depth, of coarse sand; the fall is from 1 in 5,000 to 1 in 2,500.

5. The river-bed is of fine sand; the fall is from 1 in 20,000 to 1 in 5,000.

6. Lastly, the river-bed is covered with large pebbles and boulders; the fall is from 1 in 333 to 1 in 667.

The back-water caused by these obstructions thrown

across the rivers may reach 3 ft. in height, and if the valleys are not protected, it is necessary to raise the banks or dykes above the dam to prevent overflow. For this reason the general practice has been to reduce the importance of this back-water as much as possible, by adopting for the crown of the work a level from 30 to 40 in. below the maximum desired. The rest of the height is obtained by movable crest-pieces, flush-boards, or horizontal planks held in place by upright bars or frames set in the masonry of the dam.

The openings for waste water or overflow gates are usually of masonry, the gates being placed in them and held by the piers. The gates are generally composed of horizontal boards or iron plates. In many cases wooden gates are used; in others iron gates, lifted by chains and windlasses, and moving on rollers which work on rollers running in grooves in cast-iron plates set in the masonry. When the height is considerable the gate is divided into two parts, which can be worked separately, and are so arranged that the lower edge of the upper gate rests on the top edge of the lower one.

In a few cases, in rivers subject to sudden rise, gates have been used which oscillate around a horizontal axis, and which can be opened and closed by chains.

These general remarks may be emphasized and perhaps explained by condensed descriptions of some of the more remarkable dams, which will be given in the next part.

(TO BE CONTINUED.)

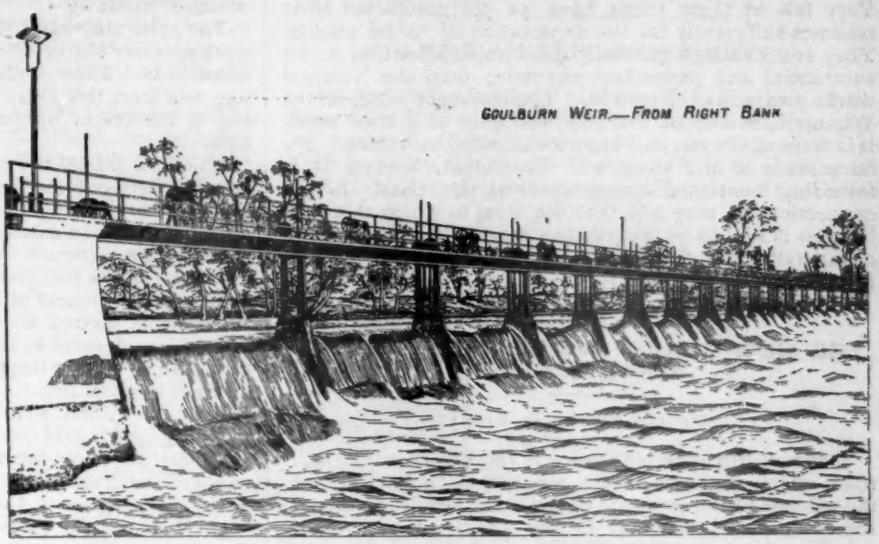
IRRIGATION WORKS IN AUSTRALIA.

(From *Indian Engineering*.)

THE Government of the colony of Victoria is alive to the benefits of irrigation as a means of ameliorating the conditions of country life in that part of Australia.

HORSHAM WEIR — ON THE WIMMERA.

The National works, constructed with that end, are of a substantial and permanent character. Their supervision, maintenance, and management are charges against the colonial exchequer. Prominent among these is the Goulburn Weir, which forms one of the subjects of the annexed plate. The illustration shows the weir during the occurrence of an extraordinary flood, with a volume of 1,423,000 cub. ft. passing over it per minute.



GOULBURN WEIR.—FROM RIGHT BANK

The site was selected as being the nearest point to the irrigation district at which a rock foundation was obtainable near the surface suitable for carrying a masonry structure. The summer level of the river is raised 45 ft. by the weir, the depth of water from raised water-level to the bed of the river being 50 ft. The weir is of concrete, composed of Portland cement, sand, and broken stone, backed with granite blocks in steps. The lower portion across the channel-way was constructed in four sections within coffer-dams; six tunnels, each of 44 sq. ft., carrying the ordinary flow of the river while the superstructure was in progress. These tunnels are closed at the face by cast-iron gates. The water-way over the weir for the passage of floods is occupied by 21 gates, each 20 ft. wide and 10 ft. high, lowering into recesses or chambers in the body of the structure as may be required to accommodate the flow of the river, and to maintain the water-level as far as possible at 50 ft. above the bed. To lower the gates into chambers was considered the best arrangement with regard to the conditions of the river, and to keep the works as compact as possible. The flood conditions might have been modified by increasing the depth or length of flood water-way, but the provision made was considered adequate, sufficient land being taken to cover the heading. The power for working the flood-gates is obtained from three 30½-in. Leffel turbines. Hand-gearing is also provided over each gate. The turbines can be worked together or separately, and any turbine can be brought into gear with any gate or gates. The head under which the turbines will be worked will vary from 3 ft. to 13 ft., according to the state of the river below the weir, giving from 3 H.P. and 78 revolutions per minute to 27.3 H.P. and 163 revolutions per minute, according to the varying conditions. An electric lighting plant of five arc lamps, driven by a 23-in. Leffel turbine, is provided for night-work.

The off-take channels have head-gates, each 10 ft. × 7

ft., pivoted vertically, and worked by worm and worm-wheel gearing. The western off-take has 14 and the eastern 4 of these gates.

Another system for the extension of irrigation in the colony is that through the medium of "irrigation trusts." Very few of these trusts have as yet completed their schemes sufficiently for the expectation of useful results. They are, although generally good and efficient, of a less substantial and permanent character than the National works previously referred to. The Horsham Weir, on the Wimmera, is one of the best examples of a trust work. It is built of timber, and known as a silled structure. We have made it the subject of illustration, because it is favorably mentioned among works of that class. In this connection we may add that the trust to which this weir belongs is said to be progressing steadily in the direction of satisfying the domestic, stock, and irrigation requirements of its constituents.

THE NEW PENNSYLVANIA RAILROAD TERMINAL STATION.

(From the Philadelphia *Record*.)

THE new Broad Street Station of the Pennsylvania Railroad, which is shown in the accompanying cut, will be, the officials of the company declare, the largest and handsomest railroad terminal in the world. Work on the superb structure, which will certainly be one of the noted buildings of the United States, is now progressing rapidly, and within a year or a little more Philadelphians may pride themselves on the possession of this splendid station.

The plans of the new building have been prepared by Furness, Evans & Company, of Philadelphia, and approved by the officials of the company after some minor alterations. The structure is designed to be a mammoth 10-story building of modern Gothic architecture, whose exterior will be finished to correspond with the present station, as its construction will be of granite and brick, with the highly ornamental trimmings and bas-reliefs in terra cotta. Necessary modifications will be introduced in the lines of the new station, so as to obviate any dwarfing of the present building, even though the height of the main tower will be 240 ft., and also to better create a uniform harmonious whole after its completion, when it will stand the most imposing railroad terminal station and shed in the world.

It will extend to Market Street, occupying all of the ground south of the present station between Market Street and the present station, extending west on Market Street over Fifteenth Street, and 60 ft. beyond. This immense building site will afford an extensive increase in the practical operating area and create greater space accommodations for the traveling public. Reducing the territory occupied by the new station and shed to simple figures, it is shown that 4¾ acres of ground are to be under roofing.

The main entrance for outgoing passengers will be at the corner of Broad and Market streets and will be semicircular and imposing in design. Another entrance will be on Filbert Street, west of Broad, and a score or more of great arched entrances will line the front of the building on Broad Street.

All of these entrances will be protected by a glass-covered arcade or awning extending the entire length and covering the pavements on the Broad and Market streets façades, which in inclement weather will form ample shelter for outgoing or incoming passengers.

The plan for the lower floor, which has been designed with the greatest study and care, promises to afford the greatest possible convenience to the public. The entrance hall on the ground floor will extend from Market Street to the baggage-room on Filbert Street, affording commodious accommodations for incoming passengers and avoiding any possibility of a crowd or rush about the ticket windows, the elevators or stairways, and is so designed that the mass of arriving and departing passengers will be entirely separated. The Broad Street side will be virtually thrown open with entrances, and the adjustment of the ticket offices and the exceptional facilities for comfort and rapidity when tickets are to be bought could not be improved upon. The ticket office will be in the middle of the building, situated about where the large exit now is. The main stairway will be immediately back of the range of ticket windows.

The main stairway will consist of two broad flights, one starting from Market Street and the other from the Filbert Street side. These flights will ascend to a common landing, and from this there will be one grand stairway entering in the center of the second or main floor of the station.

On either side of the main flight are two large elevators running between the first floor or entrance hall and the second floor waiting rooms and train entrances. These elevators will also communicate directly with the cabs and carriages on Fifteenth Street.

In view of the fact that the Pennsylvania Railroad Company was the pioneer of the present railroad cab, carriage and hansom service, it is not a surprise to find the space that will be devoted to cabs in the plans of the new structure, and to see the improved conveniences for the public through this medium.

Near the Filbert Street side, on Broad Street, there will be a large *porte-cochere* for carriages bringing passengers to the station, while opening from it there will be a greatly enlarged baggage-room. Thus the arriving passengers having baggage with them to check will be able to purchase their tickets, check their luggage and ascend by the stairways or elevators to the train floor without having to retrace their steps; at the same time they will avoid confusion by coming in contact with the departing traveler. The stand for cabs will be on the Fifteenth Street side, where it will be easy of access by outgoing passengers, and when completed it will occupy about half of the length of the building, making it about twice the present space devoted to this service.

Entering the main floor from the grand staircase there will be presented an interior equipped with general waiting rooms of every description.

The passengers' reception or waiting-room will be extended out to where the line of iron fence is to-day, and the lobby will be 50 ft. wide instead of 30 ft. as it is at present. The grand stairway will open directly in the center of the main waiting-room, 82 ft. wide by 136 ft. in length. Arranged on this floor will be the dining-room, 29 ft. wide by 111 ft. in length. This will extend along the Broad Street front, while adjoining it will be a restaurant 32 ft. wide by 82 ft. in length. Independent of the main waiting-room there will be a women's waiting-room 56 ft. by 82 ft., and a very large room for men. There will be also Pullman and telegraph offices, barber shops, retiring rooms and news-stands. In its interior arrangement, designs and ornamentation it will embody everything of utility, combined with accessories to please the eye.

The main entrance to the office building will be on the Market Street façade, midway between Fifteenth and Broad streets.

Leading from this dignified entrance will be the staircases and three elevators for the exclusive use of the business public and the officers.

There will be another entrance to the office building proper at the corner of Fifteenth and Filbert streets for the use of the army of clerks and employés.

Definite plans for the interior divisions of the upper floors have not as yet been outlined, but it is estimated there will be about 200 various offices so as to accommodate all the officials and clerks who are now in the general offices on Fourth Street. In completing the plans an ample margin has been left in office room for the enormous yearly increase of officials and employés. To this end the new part of the building will be 10 stories high, or eight stories above the main waiting-room on the second floor.

The kitchens will be on the floor over the station dining-rooms and luncheon tables, and will be replete with every modern convenience. All the heats and odors are to be carried off by a system of ventilation. An entrance and elevator at Fifteenth and Filbert streets have been de-

signed for servants, and all necessary supplies for the dining-rooms and kitchens will find their entrance and exit there.

The design of this immense building, as a whole, is also susceptible, should the requirements of the road demand an increased space, of being extended over the present station to a 10-story structure corresponding with the new station as it will appear when erected, thus doubling the capacity of the work now in contemplation and still preserving a harmonious architectural effect.

This great iron and glass portal to Philadelphia will be the largest railroad train-shed in the world, not excepting anything of like construction in this country, or the Midland, the St. Pancras, or the London, Chatham and Dover

THE NEW PENNSYLVANIA RAILROAD STATION, BROAD STREET, PHILADELPHIA.

stations in London. It will cover an area 707 ft. long, 307 ft. wide, and 140 ft. in height from the platform to the ridge of the central ventilator. The main arches will have a clear span of 294 ft. at track level, and a clear height at the center of 104½ ft. above the top of the rail. The entire structure, with its 6,000,000 lbs. of iron, will present the appearance of a gigantic sun-parlor, for its extensive roof is to be largely composed of heavy translucent glass in iron frames. The glass in the roof alone will cover an area of 1¼ acres. The arches span an extreme width which measures 307 ft. without any intervening obstructions or supports, leaving the space clear for 16 tracks and the necessary platforms.

The exteriors of the train hall, both on Market and Filbert streets, have been designed to accord perfectly with the style of architecture used in the station building, thus obviating the usual abrupt incongruity so often seen between station buildings and the train halls, thus making the entire exterior one consistent design.

The height of the roof, the extensive surface of glass used in the covering, will render the shed very light, while excellent ventilation, also attributable to its altitude, will serve to keep the air free of smoke.

One of the most interesting problems connected with the new station will be its construction without interfering with the volume of shipping and travel to and from Broad Street Station. It seems perfectly safe in prophesying that not a detention will occur, however, when the work in New York and Jersey City is taken as a precedent, for there, during the entire construction of the great shed, adjoining buildings and miles of new roadbed, not so much as a single wheel was clogged nor a detention caused in travel.

COLUMBIAN EXPOSITION NOTES.

AN application has been made by E. L. Corthell, Chairman of the Executive Committee of Associated Engineering Societies, Chicago, for 1,200 sq. ft. of space in the Transportation Building. The space is to be used by the staff of the Associated Engineering Societies of the United States and Canada for the purpose of aiding engineers from all over the country in examining the engineering exhibit and also the general exhibit of the Exposition. Large photographs of bridges are promised to the Department of Transportation exhibits by the King Bridge Company, of Cleveland, and the Union Bridge Company, of New York, for the display of which wall space has been asked. Joaquin Filippe Nery Delgado, President of the Society of Portuguese Civil Engineers, at Lisbon, applies for 96 sq. ft. of space for books, albums of photographs and albums of drawings and engravings. The State of New York, through Edward Hannan, of Albany, Superintendent of Public Works, wants 5,000 sq. ft. of space in the marine division of transportation exhibits. It is proposed to exhibit the State canal system of New York and photographs, maps, plans, models and drawings of canals, structures, elevators, boats, feeders and towing systems upon navigable waters connected therewith. The Edgemoor Bridge Works of Wilmington, Del., will include in their exhibit metal sections of various bridges, viaducts and other structures, and also large photographs of large and important bridges designed and erected by the firm.

THE special train bearing the 10 big logs destined for the flagpoles for the Washington World's Fair Building at Chicago will be run in three sections of 14 cars each. Each of the logs equals the length of seven flat cars, though they are loaded in such a manner that the weight is

carried by two of the cars. With the exception of the two largest, the logs are placed two together on the cars, but it was impossible to load the two largest in that manner, owing to their enormous weight.

The two end cars of the sections will support the load on a raised block working on a pivot. The other cars will be empty, and the logs will extend over them above the car-floors. This arrangement is necessary owing to the curves in the road. When the train is on a curve, the first and last cars of the section will of course not be in the same straight line, and if the logs were supported by all the cars, it would be impossible to round the curves without breaking either the logs or the cars. To overcome this difficulty the movable blocks on the two end cars are brought into play, and while the empty cars curve around a bend in the track the pivots are also turned, permitting the logs to always retain the same relative position with respect to each other. On sharp curves the middle of the load will be entirely clear of the cars at the center of the section, and will lie parallel to a tangent drawn at the outer edge of the curve. When the curve is passed the pivots again throw the logs back to their original position.—*Spokane Journal.*

THE UNITED STATES NAVY.

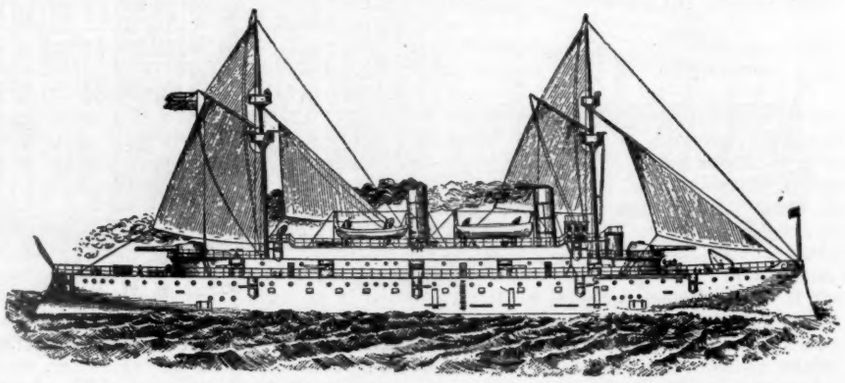
THE progress of the work on the armored cruisers *Maine*, at the New York Navy Yard, and on the *New York*, at the Cramp yards, in Philadelphia, is still delayed by the slow delivery of the armor plates. The dates at which these ships will be ready for service are still uncertain.

The other new ships under construction are advancing well, with the exception of the *Cincinnati*, at the New York Yard. The damage done to the engines by the recent fire in the machine shop will take some time to repair, and the launch of the ship has been postponed for the present. Several of the other new ships, however, will soon be ready for service.

The torpedo-boat No. 2, which is under construction by the Iowa Iron Works at Dubuque, Ia., will soon be ready for launching.

LAUNCH OF THE "OLYMPIA."

The next ship to be launched is cruiser No. 6, which a recent order from the Navy Department has named *Olympia*, after the capital city of Washington. The accompanying sketch is from the plans of this ship published in the report of the Bureau of Construction.



CRUISER "OLYMPIA," UNITED STATES NAVY.

The *Olympia* is a twin-screw, protected cruiser, of the following dimensions: Length on load water-line, 340 ft.; extreme breadth 53 ft.; mean draft, 21 ft. 6 in.; displacement at normal draft, 5,500 tons.

This ship has a protective deck 4½ in. thick on the slopes and 2 in. on the flat over the machinery space; 3 in. on the slopes and 2 in. on the flat forward and abaft of it.

A belt of water-excluding material 33 in. thick, in coffer-dams extending 4 ft. above and 4 ft. 5 in. below the load water-line, extends the whole length of the vessel. Coal protection is afforded the machinery by the location of the bunkers along the side below the protective deck, and above that deck for the length of the engine and boiler space. The armored ammunition tubes are 3 in. thick, and the conning-tower 5 in. The hull plating is increased in thickness in the wake of all machine guns.

The main battery will consist of four 8-in. breech-loading rifles in barbette turrets 4 in. thick, and ten 5-in. rapid-fire guns protected by 4-in. segmental shields. The secondary battery will consist of fourteen 6-pounders, six 1-pounders and four Gatling guns. In each of the lower military tops will be mounted a 37-mm. Maxim gun and a 1-pounder Hotchkiss gun. The torpedo outfit will consist of six launching tubes for automobile torpedoes, one fixed at the stem, one at the stern, and two training tubes on each broadside.

There are two vertical, direct-acting triple-expansion engines, one to each screw. The cylinders are 42 in., 59 in. and 92 in. in diameter and 42-in. stroke.

Steam will be furnished by six boilers, two single-ended, each 15 ft. 3 in. in diameter and 10 ft. 11½ in. long, with four corrugated tubular furnaces; the other four double-ended, 15 ft. 3 in. in diameter and 21 ft. 3 in. long, with light furnaces. They carry 160 lbs. working pressure.

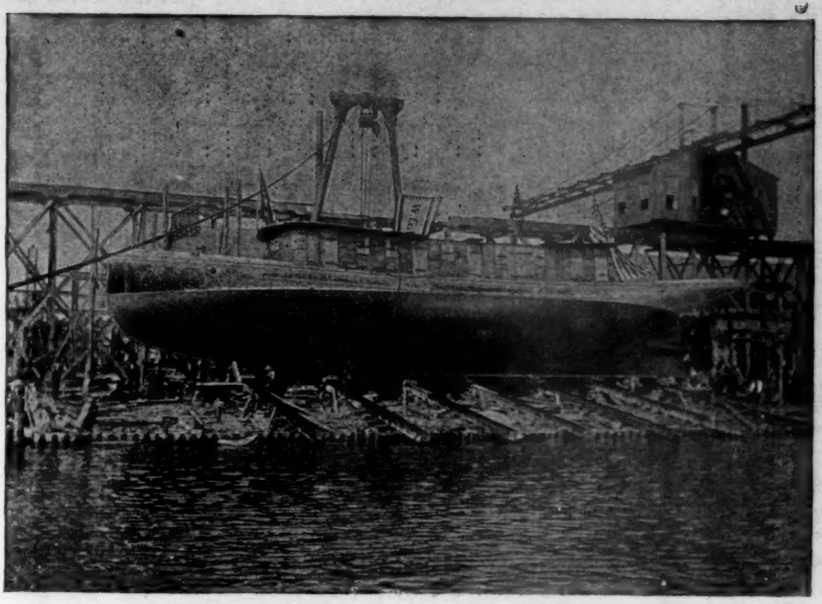
Working at full power and at about 128 revolutions per minute, the engines are expected to develop 13,500 H.P. and to give the ship a speed of 20½ knots an hour.

The full coal capacity will be 1,300 tons. At maximum speed this supply will give a steaming radius of 2,192 knots. At a speed of 10 knots it will give a cruising endurance of 13,000 knots, or about 54 days' steaming.

A LAKE-BUILT OCEAN TUG.

THE first large tug built at a lake ship-yard for ocean towing purposes was recently launched at the yard of F. W. Wheeler & Company, in West Bay City, Mich. The accompanying engravings are from photographs, and represent the tug upon the ways ready for launching; the launch, and the vessel in the water after launching. It will be noticed that the ways are parallel to the water and that the tug was launched broadside. This method is somewhat risky in appearance, but has been successfully carried out at Bay City and elsewhere with a number of vessels.

This tug, which is named the *W. G. Wilmot*, after her owner, and is intended for service at New Orleans, is of steel and of the following dimensions: Length of keel, 99 ft.; length over all, 110 ft. 6 in.; beam, molded, 23 ft.; extreme draft, 11 ft. The propeller is of the Trout pattern, and is 9 ft. 3 in. in diameter and 12 ft. pitch. It is driven by a triple-expansion engine with cylinders 16 in., 24 in., and 40 in. diameter by 28 in. stroke. The engine is provided with steam reversing gear, this gear being controlled by a differential motion. The valves are balanced, the high-pressure cylinders being controlled by a piston-valve, the intermediate and low-pressure by ordinary double-ported slide-valves driven by a link-motion of the double side-bar type. The engine has a Wheeler patent condenser with combined air and circulating pump. The boiler is of the cylindrical type, 12 ft. 6 in. in diameter and 12 ft. 8 in. long. There are three furnaces 40 in. in diameter and 8 ft. long, and 218 tubes 3¼ in. in diameter and 8 ft. 6 in. long. The grate area is 63 sq. ft., and the heating surface 2,100 sq. ft. There is also a horizontal return-tube donkey boiler and feed-pump of ample size and a "metropolitan" double-tube injector. A filter for extracting grease from the feed-water is also fitted. An important feature in the equipment of the fire-room is a feed-water heater having 69 brass tubes 1¾ in. in diameter and 8 ft. long, through which all the exhaust steam from the pumps passes, heating the water surround-

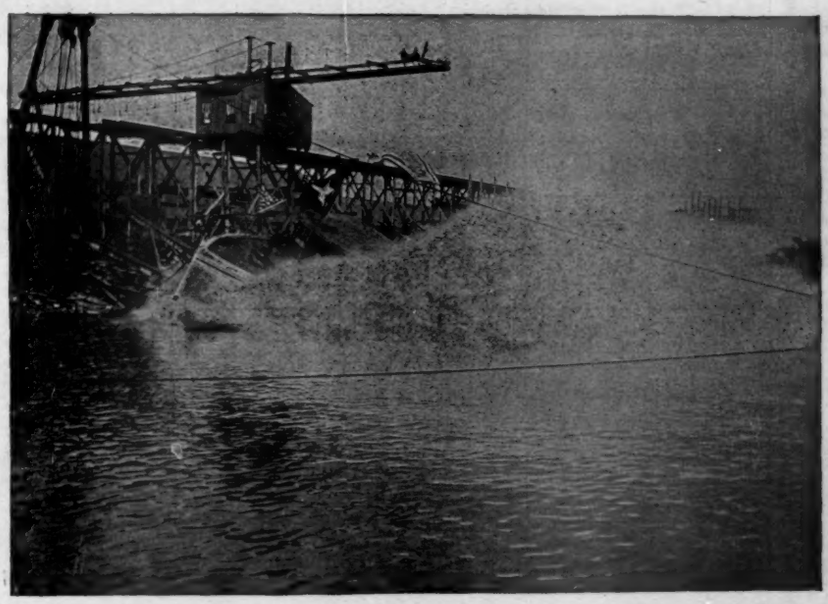


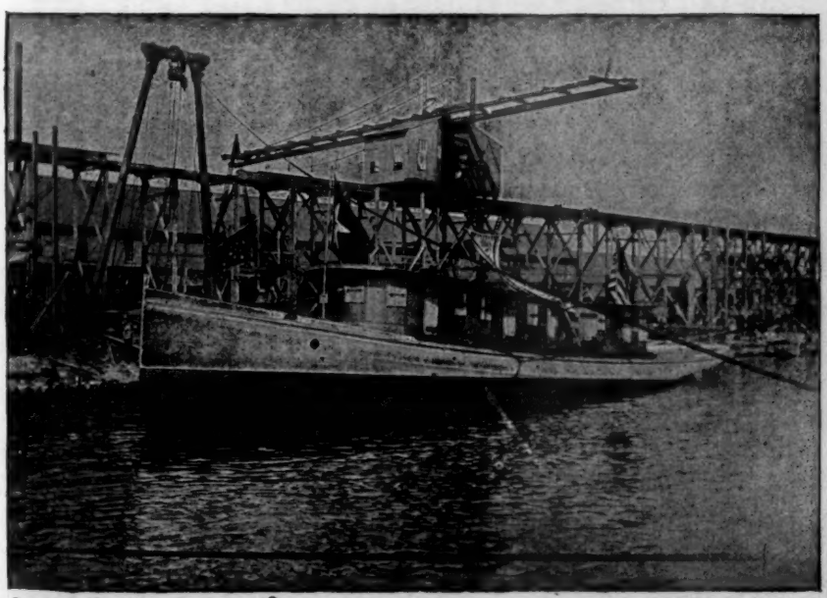
LAUNCH OF THE "W. G. WILMOT," AT WEST BAY CITY, MICH.

ing the tubes. There is a large fire pump, a 6-in. bilge suction, and the tug is provided with hose for wrecking purposes.

She is fitted with Elwes' steam steering gear, which has given great satisfaction in service, being simple in its construction and operated by a single lever in the pilot-house. She has a complete electrical outfit, including search-light.

The trial trip took place on Saginaw Bay, October 11, and was very successful, the party present on board being highly pleased with her performance. A speed of 16 miles an hour was made, with the engines not working up to their maximum. A number of good cards were taken from the engine, which developed 700 H.-P. with 160 lbs. steam, the propeller making 125 revolutions. The air-pump maintained a vacuum of 26 in. while the engines were running full speed.





This tug is on her way to New Orleans by way of New York, and will shortly be in service.

Foreign Naval Notes.

On July 7 last there was launched at Yokosuka, Japan, the second-class cruiser *Akitsushima*. The dimensions of the vessel, which is built of steel, are: Length, 300 ft.; breadth, 43 ft. 1 in.; draft, 18¼ ft.; and displacement, 3,150 tons. Motive power will be supplied by triple-expansion horizontal engines of 8,400 H.P., by which a speed of 19 knots is expected to be attained. The *Akitsushima*, which was begun in March, 1891, is the thirteenth vessel constructed at Kokosuka, besides a number of small torpedo-boats.

At the Columbus naval parade at Genoa, in September, a large number of war-ships of different nations were present. The United States was represented by the *Newark* and the *Bennington*. In writing of this naval parade a distinguished French authority comments on the light protection given to the guns on many of the cruisers. As to the armored ships, he comments on the fact that their protection in most cases is hardly sufficient to meet the attack of ships armed in the latest fashion with rapid-fire guns of considerable caliber and firing shells with high explosives. The heavily armored vessels, like the English *Sansparril* and the Italian *Duilio*, are comparatively slow and hard to manage in a seaway, while the 110-ton guns of the *Sansparil* would be almost useless except in calm weather. In other words, the limit of weight of armor which a ship can carry has been about reached in these great battle-ships, and it is still an open question whether they can stand in fight against a fleet of smaller but more active cruisers. Speed and ability to maneuver may, after all, be the deciding points in a naval fight, and the heavy battle-ship may be a useless encumbrance to her consorts. This seems to be the general tendency of naval opinion abroad.

LOCOMOTIVE RETURNS FOR THE MONTH OF JULY, 1892.

Name of Road.	Number of Serviceable Locomotives on Road.	Number of Locomotives Actually in Service.	Locomotive Mileage.					Av. Train.		Coal Burned per Mile.						Cost per Locomotive Mile.							Cost per Car Mile.		Cost of Coal per Ton.
			Passenger Trains.	Freight Trains.	Service and Switching.	* Total.	Average per Engine.	Passenger Cars.	Freight Cars.	Passenger Train Mile.	Freight Train Mile.	Service and Switching Mile.	Train Mile, all Service.	Passenger Car Mile.	Freight Car Mile.	Repairs.	Fuel.	Oil, Tallow and Waste.	Other Accounts.	Engineers and Firemen.	Wiping, etc.	Total.	Passenger.	Freight.	
										Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	$
Alabama Great Southern	....	50	39,121	73,917	37,989	151,027	3,021	....	....	62.37	78.43	47.85	65.57	....	....	5.10	4.10	0.27	0.50	6.30	2.10	18.37	....	....	....
Alabama & Vicksburg	....	18	18,030	20,945	10,303	49,278	2,738	....	....	51.02	90.90	46.84	68.26	....	....	5.30	5.40	0.30	0.70	6.40	1.80	19.80	....	....	....
Atchison, Topeka & Santa Fé	834	740	.....	.....	373,868	2,148,162	2,903	....	....	...	....	....	77.10	....	....	4.88	5.94	0.30	0.13	6.57	1.49	19.31	....	. ..	1.47
Canadian Pacific	596	....	511,845	730,330	252,227	1,715,935	2,879	. ..	....	....	....	....	59.14	....	....	3.38	10.29	0.38	....	5.27	1.31	20.63	....	....	3.43
Chic., Burlington & Quincy	517	....	.....	. .....	.....	1,778,986	3,441	5.33	18.04	....	....	....	75.90	....	....	4.57	5.00	0.20	0.20	6.52	....	16.49	....	...	1.32
Chicago & Northwestern	869	....	704,292	1,307,945	817,723	2,829,960	3,257	....	....	....	....	....	75.53	....	....	3.30	6.95	0.38	....	6.34	0.85	17.82	....	....	1.82
Cincinnati Southern	....	101	82,812	171,861	82,293	336,966	3,336	....	...	49.50	110.49	33.28	78.13	....	....	4.20	4.50	0.28	0.80	6.50	1.60	17.88	....	....	....
Cleve., Cinn., Chic. & St. L.	....	....	.....	.....	.....	.....	...	....	...	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Cumberland & Penn	23	22	5,532	30,721	.....	36,253	1,648	....	....	....	....	....	80.64	....	....	4.18	4.30	0.40	....	....	1.20	9.88	.. .	....	....
Delaware, Lackawanna & W. Main L.	....	....	....	.....	.....	.....	....	....	....	....	....	....	.. .	....	....	....	....	....	....	....	....	....	....	....	....
Morris & Essex Division	157	....	172,358	270,042	12,265	424,665	2,705	....	....	....	....	....	54.23	....	....	3.69	8.49	0.38	...	6.21	....	18.77	....	....	.. .
Hannibal & St. Joseph	78	68	77,471	144,785	36,882	259,138	3,811	4.95	17.63	.. .	....	....	75.90	13.96	5.46	6.46	5.39	0.24	0.21	6.93	....	19.23	....	....	1.28
Kan. City, F. S. & Mem	....	146	101,161	194,796	112,153	408,110	2,795	....	....	....	....	....	51.77	....	...	3.64	4.43	0.29	0.46	7.33	....	16.15	....	....	1.65
Kan. City, Mem. & Birm	41	40	36,208	51,822	19,84[1]	107,871	2,697	....	....	....	....	....	58.22	....	....	2.71	3.50	0.27	0.39	6.99	....	13.86	....	....	1.15
Kan. City, St. Jo. & Council Bluffs	....	44	59,791	47,258	43,406	150,449	3,419	4.93	21.65	....	....	....	59.10	11.57	4.28	5.61	4.99	0.12	0.09	5.49	....	16.18	....	....	1.79
Lake Shore & Mich. Southern	588	561	440,391	685,139	584,405	1,709,935	3,048	....	....	56.27	80.03	31.03	57.90	....	....	3.19	4.49	0.16	....	6.88	0.22	14.94	....	....	1.40
Louisville & Nashville	....	*339	441,697	837,990	407,635	1,686,422	3,772	5.14	16.80	60.77	104.80	58.33	78.13	11.87	6.05	4.06	6.59	0.26	1.37	6.10	0.59	18.97	3.09	1.39	1.70
Manhattan Elevated	....	278	749,143	.....	56,965	806,108	2,900	....	...	....	....	....	38.09	....	....	2.20	7.60	0.30	....	8.70	....	18.80	....	....	3.96
Mexican Central†	146	116	.....	.....	.....	388,544	3,346	....	...	...	....	....	60.70	....	....	4.74	13.82	0.47	0.20	5.53	0.84	25.60	....	....	5.32
Mil., L. S. & Western	112	108	82,685	159,778	120,470	362,933	3,453	....	....	....	....	....	66.18	....	....	2.77	9.24	0.26	....	6.12	0.92	19.31	....	....	2.80
Minn., St. P. & Sault Ste. Marie	....	....	69,035	132,258	42,947	244,240	....	4.66	20.03	....	....	....	60.34	....	....	3.29	9.92	0.19	....	6.33	....	19.73	....	1.53	3.26
Missouri Pacific	....	....	.....	..... .	.....	..... .	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	..	....	....
N. O. & Northeastern	...	35	30,250	57,206	27,254	114,710	3,277	....	....	65.57	106.38	36.90	80.00	....	....	4.90	6.70	0.30	0.40	6.50	1.60	20.50	....	....	....
N. Y., Lake Erie & Western	618	....	479,771	952,154	297,158	1,729,083	2,798	4.90	22.70	84.30	120.10	63.10	...	17.10	5.30	4.61	6.45	0.40	1.65	7.16	1.17	21.44	...	1.55	1.28
N. Y., Pennsylvania & Ohio	259	...	148,185	429,387	139,364	16,936	2,768	6.00	18.20	67.00	117.30	66.50	....	11.20	6.50	4.29	5.62	0.31	1.75	6.85	1.03	19.87	....	1.64	1.15
Norfolk & Western, Gen. Eastern Div.‡	....	143	96,390	239,493	63,863	397,746	2,782	4.80	19.50	....	...	....	75.24	....	....	6.80	2.90	0.80	....	....	....	10.50	....	...	....
Durham Division‡	....	5	7,182	13,680	3,000	23,862	4,772	5.00	3.00	...	....	....	43.01	....	....	1.90	4.30	0.50	....	.....	....	6.70	....	....	....
Radford Division‡	....	50	16,368	111,312	10,537	138,217	2,764	5.40	18.20	....	....	....	117.65	...	....	9.50	4.80	0.70	....	....	....	15.00	....	....	....
Pulaski Division‡	....	28	26,011	43,568	10,175	79,754	2,848	5.10	13.30	....	....	....	92.16	....	....	3.70	13.10	0.60	....	...	....	17.40	...	....	....
Clinch Valley Division‡	....	36	21,435	51,178	16,685	89,298	2,480	3.90	10.70	....	....	....	106.38	....	....	6.20	4.30	0.90	....	....	....	11.40	....	....	....
Winston-Salem Division‡	....	9	15,114	12,586	3,437	31,137	3,460	2.40	8.60	....	....	....	69.68	....	....	5.60	2.50	0.90	....	....	....	9.00	....	....	...
Old Colony	....	229	374,075	135,489	129,508	639,072	2,791	....	....	....	....	....	54.49	....	....	3.31	10.22	0.61	....	6.55	0.77	21.46	....	....	3.75
Philadelphia & Reading	....	....	491,435	713,704	528,443	1,733,582	....	....	....	....	....	....	74.93	....	....	4.13	4.19	0.33	....	5.74	0.41	14.80	.. .	....	....
South. Pacific, Pacific System	710	....	.....	.....	.....	1,802,710	2,539	....	....	....	.. .	....	68.47	....	. ..	4.75	18.30	0.40	2.07	7.36	1.11	33.99	....	...	5.42
Union Pacific	996	....	724,745	1,306,504	467,172	2,498,421	2,508	5.72	16.04	....	....	....	93.94	13.51	7.90	6.96	9.18	0.43	0.77	8.02	1.13	26.49	4.23	2.02	1.95
Vicksburg, S. & P.	....	14	11,614	10,868	9,856	32,338	2,310	....	....	49.26	80.37	25.25	53.19	...	....	2.40	5.70	0.24	1.00	6.60	2.50	18.84	....	....	....
Wabash	403	351	409,313	654,478	271,374	1,335,165	3,804	5.12	17.43	64.33	94.52	55.56	77.34	12.56	5.42	3.08	4.39	0.29	....	6.28	0.87	14.81	2.46	0.99	1.13
Wisconsin Central	151	130	138,353	217,176	82,826	438,355	3,372	....	....	...	....	....	72.07	....	....	2.94	9.07	0.28	....	7.16	....	19.45	....	....	2.47

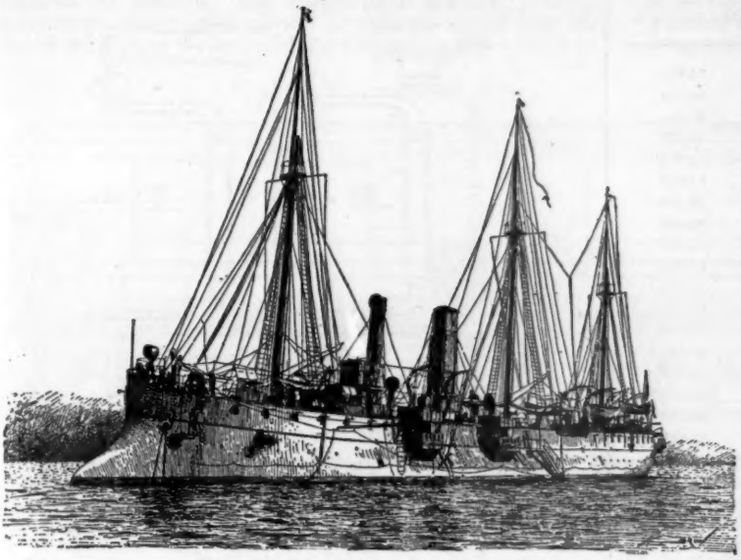
NOTE.—In giving average mileage, coal burned per mile and cost per mile for freight cars, all calculations are made on the basis of *loaded* cars.

* Number of engines in revenue service only; average mileage is also based on revenue service.

† The Mexican Central Railroad reports 19.6 units of work per $1 of expense; 180.1 units of work per ton of coal; 11.10 lbs. of coal per unit of work. The unit of work is 100 gross tons hauled one mile in one hour on a straight and level track.

‡ Wages of engineers, firemen, and wipers not included in cost.

THE accompanying illustration, from *Le Yacht*, shows the third-class cruiser *Lalande*, of the French Navy. This vessel is a twin-screw steel cruiser, built to attain a speed of 19 knots with forced draft. She has the high freeboard, narrow deck and long ram bow which characterize the French cruisers of her class.



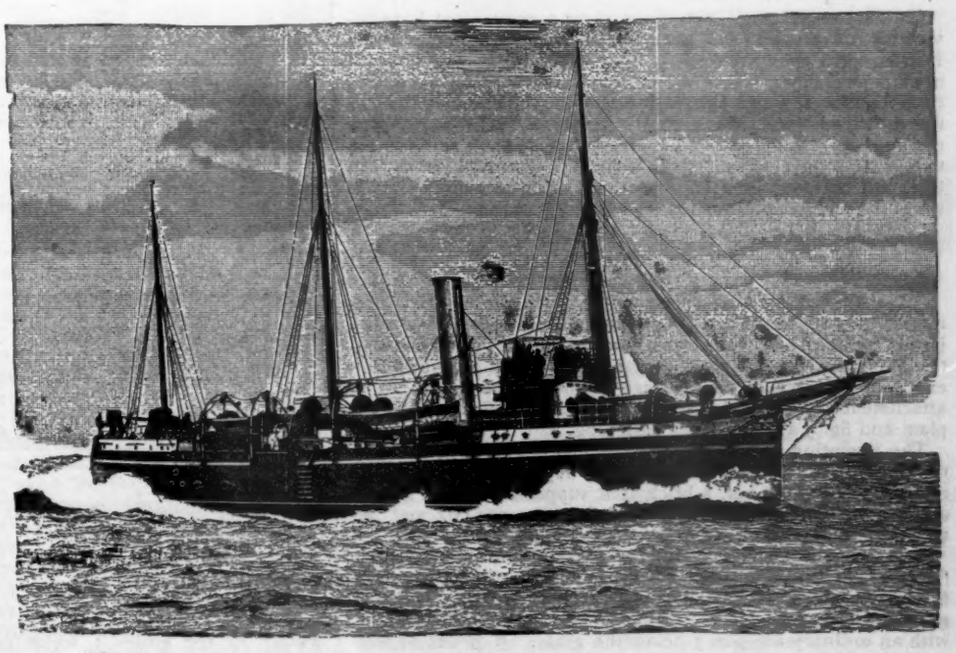
THIRD-CLASS CRUISER "LALANDE," FRENCH NAVY.

The *Lalande* is 311.6 ft. long, 29.5 ft. beam, 17 ft. mean draft and 1,877 tons displacement. Her engines work up to 6,000 H.P. She carries four 5.5-in. breech-loading rifles; three rapid-fire guns; four revolving cannon, and five torpedo tubes. She has no armor except a protective deck covering the machinery and magazines.

THE sea-going torpedo-boat *Dragon*, recently completed in the Normand yards at Havre, for the French Navy, on her trial trip maintained for five hours an average speed of 18.2 knots an hour. With forced draft and engines working to their highest point she kept up for one hour the remarkable speed of 25.03 knots. The consumption of coal at 18.2 knots was 1,534 lbs. per hour; it reached 3,967 lbs. per hour at the highest speed, with forced draft.

THE firm of Sir W. G. Armstrong & Company, at Elswick, England, has nearly completed two cruisers for the Brazilian Navy. The first, the *Republica*, is 206 ft. long, 35 ft. beam, 12.8 ft. mean draft and 1,300 tons displacement. She has twin screws and triple-expansion engines which can work up to 3,300 H.P. with forced draft, giving a speed of 17 knots. She carries six 4.7-in. cannon, four 6-pdr. rapid-fire guns, six machine guns and four torpedo-tubes.

The second ship, which has been named *Tridentes*, is a twin-screw cruiser 173 ft. long, 30 ft. beam, 10.7 ft. mean draft and 800 tons displacement. Her armament will consist of four 4.7-in. guns, three 6-pdr. rapid-fire guns, four machine guns and two torpedo-tubes. Her engines are of the triple-expansion type, and can work up to 1,200 H.P. with forced draft. The contract speed of this ship is 14½ knots at full power.



CRUISER "TRIDENTES," FOR THE BRAZILIAN NAVY.

THE Elswick yards have also nearly completed two ships for the Argentine Navy. The first is the torpedo cruiser *Aurora*, which is 204 ft. long, 20 ft. beam, 13.6 ft. draft, and 500 tons displacement. Her engines can work up to 2,300 H.P., and her maximum speed is 18 knots.

The second is a cruiser named the *Julio*, and is to be a very fast boat. Her engines are designed to develop 14,500 H.P., and she is expected to make 22½ knots an hour in smooth water. This ship is 350 ft. long, 44 ft. beam, 26 ft. mean draft and 2,560 tons displacement.

THE HIGHEST INITIAL VELOCITY.

IN the latest number of *Mittheilungen aus dem Gebiete des Seewesens* an account is given of some extraordinary results obtained in experimental firing with a Canet rapid-fire gun of 57 mm. (2.24 in.) caliber. The remarkable point about these tests is that in them the highest initial velocity on record was obtained. These tests were made in May and June last, but the results, we believe, have not been made public until the present time.

If all the conditions of the trial are considered, it will be seen that the extraordinary result obtained was not due to the weight or form of the projectile. The shot used with the 57-mm. Canet gun weighed 2.7 and 3.0 kg., which does not differ materially from those used with other rapid-fire guns of the same caliber. Thus the projectile of the 57-mm. Grüson gun weighs 2.72 kg.; of the Hotchkiss, 2.725 kg.; of the Krupp, 2.75 kg., and of the Maxim, 2.72 kg. The reason for the very high initial velocity is found in the great length of the bore of the Canet gun, and in the use of a very slow-burning powder. While the 57-mm. Grüson, Krupp, Maxim and Hotchkiss rapid-fire guns have bores of the lengths of 20, 30, 42 and 44 calibers respectively, the Canet has a length of bore of 80 calibers.

The results obtained are given in the following table, in which the original metrical figures have been reduced to feet and pounds. The powders used were varieties of the French naval powders:

No. of Shot.	Weight of Projectile.	Kind of Powder.	Weight of Charge.	Initial Velocity.	Gas Pressure.
	Lbs.		Lbs.	Feet.	Lbs. per sq. in.
1	5.95	BN, 1 Los.	1.763	2,125	14,023
2	5.95	" "	2.424	2,594	24,244
3	5.95	" "	2.645	2,801	26,944
4	5.95	" "	3.086	3,109	37,082
5	5.95	" "	3.196	3,218	3,667
6	5.97	BN, 2 Los.	2.920	2,818	27,646
7	6.61	" "	2.920	2,739	28,500
8	6.61	" "	3.086	2,821	29,162
9	5.95	BNG	2.204	2,558	19,808
10	5.95	"	2.645	2,972	27,881
11	5.95	"	2.865	3,142	31,229
12	5.93	"	2.975	3,188	31,627
13	5.95	"	2.975	3,273	35,002
14	6.61	"	2.865	3,123	34,548
15	5.95	"	3.086	3,283	35,392
16	6.61	"	3.086	3,296	42,606
17	5.95	"	3.086	3,323	36,270
18	6.61	"	3.086	3,214	37,055
19	6.61	"	3,086	3,263	37,688

The average of shots Nos. 15 and 17 showed, with a charge of 3.086 lbs. of powder and a projectile of 5.95 lbs., an initial velocity of 3,303 ft. per second. The average of shots 16, 18 and 19 gives with a charge of 3.086 lbs. and a 6.61-lbs. projectile, an initial velocity of 3,257 ft.

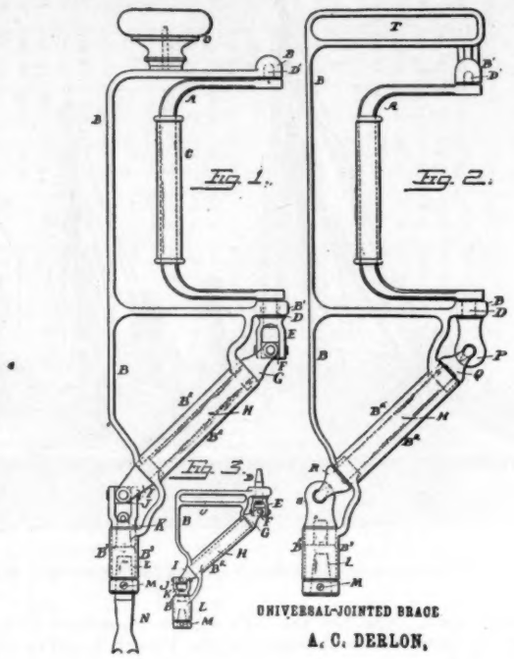
According to previous experience, the point to be feared was that so long a gun might be so far acted upon by the shot as to become slightly deflected; but it does not appear that this result followed the trials referred to.

The flight or path of the shot was so even that the gunner was able to aim at and strike a target 19.7 ft. high, placed 5,400 ft. distant, even without a special sight. Such a target would cover any ordinary ship or coast fortification.

Recent Patents.

DERLON'S UNIVERSAL-JOINTED BRACE.

THE accompanying illustrations show a convenient little device for which patent No. 481,526 was recently issued to A. C. Derlon, of Paris, France. It is a brace for boring holes in corners and other places where an ordinary brace cannot be turned; figs. 1, 2 and 3 show different modifications. It is, as the drawings very plainly show, simply a frame carrying in the upper part a brace handle, and below a shank and bit, the two being connected by a shaft having a universal joint at each end, and enclosed in a long bearing. It is so plainly shown, that further description is hardly needed.



UNIVERSAL-JOINTED BRACE

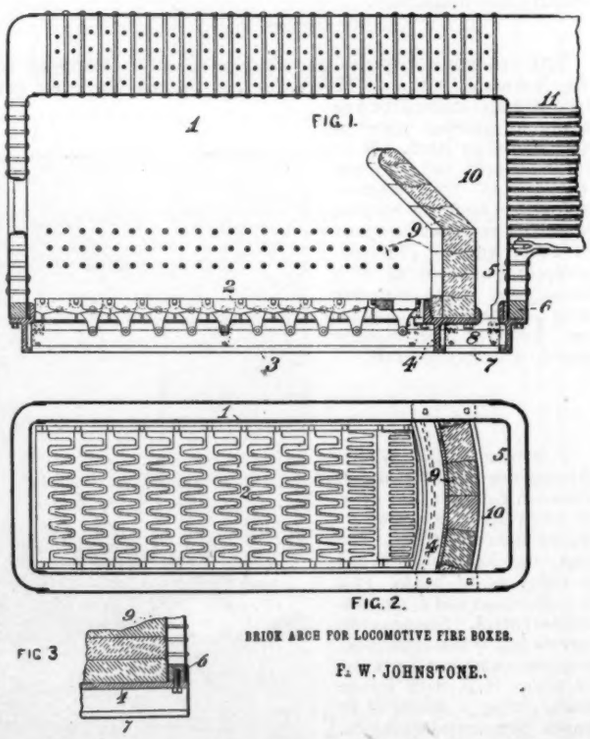
A. C. DERLON.

JOHNSTONE'S BRICK ARCH FOR FIRE-BOXES.

The annexed drawing shows a form of brick arch for locomotive fire-boxes covered by patent No. 481,232, recently issued to Mr. F. W. Johnstone, Locomotive Superintendent of the Mexican Central Railway. Its object is to admit the application of the arch to an ordinary fire-box, without the use of attachments to the side-sheets. Fig. 1 is a section, fig. 2 a plan, and fig. 3 a detail of the fastening.

The invention consists in the combination, with a locomotive fire-box, of a transverse girder or support fixed below the mud-ring or bottom bar, a brick arch supported on said girder, and an auxiliary ash-pan located below the fire-box and between the girder and the flue-sheet.

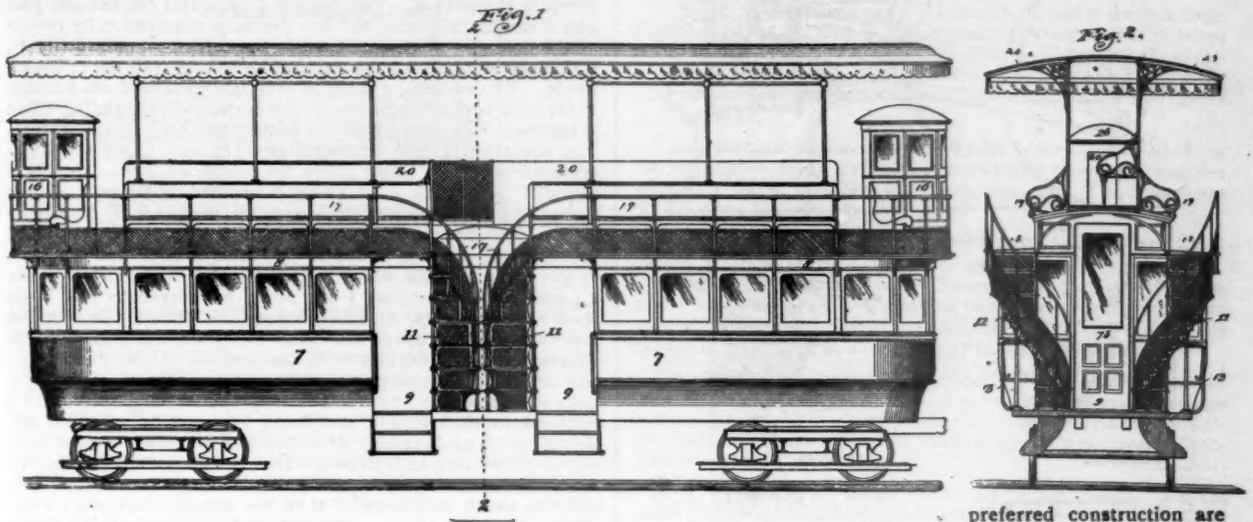
The device is shown in the drawings as applied to a Belpaire fire-box, but it can be used with any of the ordinary types of fire-box. The fire-box is provided at bottom with a suitable grate 2, which extends for the major portion of its length and with an ordinary ash-pan 3 below the grate. A girder or support 4, which is preferably of cast iron, extends across the bottom of the fire-box in front of the ash-pan 3—that is to say, at or near its end which is adjacent to the flue-sheet 5—said girder being secured at its ends either to the side members of the mud-ring or bottom bar 6 of the fire-box, as shown in fig. 3, or to the engine-frames when the fire-box is so located relatively thereto as to make such attachment convenient or desirable—for example, entirely above the frames, as is frequently the case in recent and present practice. The girder 4 forms the rear wall of a supplemental ash-pan 7, which extends below the forward portion of the fire-box to or near the plane of the flue-sheet 5, and is provided at its sides with tight doors or dampers 8. An arch or bridge-wall 9, formed of a series of fire-brick sections, and having, preferably, a rearwardly inclined upper portion, rests upon and is supported wholly by the girder 4, which may be, as shown, provided with lateral flanges on its upper surface to abut against and hold in position the lower sections of the arch 9. The space 10 between the arch and the flue-sheet is open at bottom to the supplemental ash-pan 7, and serves the purpose of a combustion-chamber in which the combustion of the gaseous products of the ignited fuel on the grate is perfected before passing into and through the tubes 11.



BRICK ARCH FOR LOCOMOTIVE FIRE BOXES.

F. W. JOHNSTONE.

It will be seen that the construction described obviates the necessity of perforating the fire-box sheets for the attachment of the supporting devices ordinarily heretofore employed, and that the brick arch may be readily put in place and removed or repaired, as required. The supplemental ash-pan 7 being practically air-tight, such cinders as may be carried over the top of the arch by the action of the exhaust fall into a space in



PULLMAN'S IMPROVED STREET CAR.

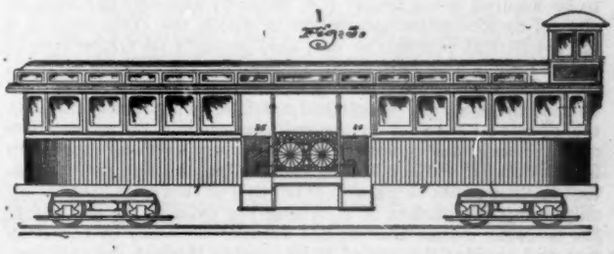
which they are undisturbed by any upward draft, and remain quiescent in the supplemental ash-pan, from which they may be removed at proper intervals through the openings controlled by the side doors or dampers 8.

PULLMAN'S STREET CAR.

In figs. 1, 2 and 3, given herewith, there is shown an improved form of street car, for which Patent No. 471,761 has been issued to Charles Pullman, of Chicago, Ill. Fig. 1 is a side view of a car; fig. 2, a cross-section; fig. 3, a plan, with part of the roof broken away to show the arrangement of seats in the body of the car. The plan and arrangement are very well shown in the drawings. The object is to do away with some objectionable features in the usual construction of street railroad cars by dispensing with the end platforms and dividing the car transversely below the deck-line into two compartments, each occupying one end of the car and communicating with each other by a central vestibule provided with side entrances, through which the passengers enter and leave the car near its middle instead of at its ends, as in the previous construction. This vestibule is covered partially or wholly, according as the car is double or single decked, and its floor is formed by the car floor. Its sides may be partically closed by central panels, and it is best to provide sliding doors on both sides of the car and on each side of the panels and steps leading from each of the doors. The vestibule may be separated from the end compartments by transverse partitions having sliding doors. The car is thus practically divided into several compartments—a central vestibule partially or wholly enclosed and provided usually with seats and adapted for smoking-room, a seating compartment at each end of the car opening off the vestibule and preferably separable therefrom, and a roof compartment with seats so arranged as to utilize all the available space without interfering with the comfort of the passengers or subjecting them to inconveniences. The conductor's position is in the vestibule, and enables him to oversee all the passengers and to rapidly collect the fares, while a special cab is provided for the driver at an elevation and apart from the passengers, so that he is in the best position to control his car.

A special feature of this invention relates to the provision of stairways leading to the roof seats. These stairways in the preferred construction are two in number, each located substantially in the plane of the sides of the car, and each stairway being located centrally of the length of the vestibule and having common steps at the bottom and branching toward their tops into two flights, which flights land the passengers facing toward the ends of the car and at four points upon the roof, so that four passengers may enter or leave the stairways at the same time. There are thus provided two separated or divided central entrances upon each side of the car, and the car may be thus rapidly filled or unloaded without confusion or delay.

Where the upper deck seats are not required, they may be omitted, and an ordinary roof used, with only the driver's cab



projecting above it, as shown on a smale scale in fig. 5. This plan of car is especially adapted for electric and cable lines.

Some Compound Locomotive Patents.

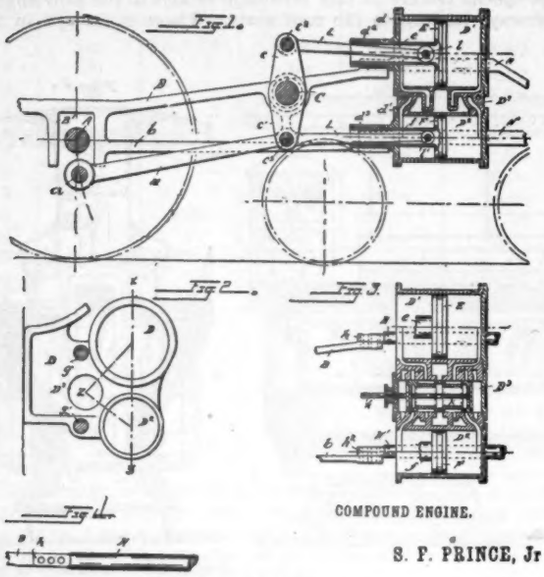
We give below two new patents recently issued for improvements in compound locomotives, or for new devices intended to increase the efficiency of that type of engine.

PRINCE'S COMPOUND LOCOMOTIVE.

This invention, for which patent No. 480,781 has been issued to Samuel F. Prince, Jr., Superintendent of Motive Power of the Long Island Railroad, is shown in figs. 1, 2, 3 and 4. Fig. 1 is a side elevation showing the cylinders in section on

line $x\,x$, fig. 2. Fig. 2 is an end view of the cylinder-casting. Fig. 3 is a sectional view taken on line $x\,z\,y$, fig. 2. Fig. 4 is a separate view of the cylindrical frame-section.

The high-pressure cylinder D^2 and low-pressure cylinder D' are represented as cast in one piece D, in which is also formed



COMPOUND ENGINE.

S. F. PRINCE, Jr

an intermediate cylindrical steam-chest D^3. In this chest is located a valve K, by means of which the steam distribution is effected, so as to cause the pistons to move in opposite directions.

The rear cylinder-heads d and d' are formed with long stuffing boxes or guides d^2 and d^3, within which move the projecting hollow trunks e and f of the pistons E and F for the high and low pressure cylinders, respectively. Within these hollow trunks at l and l' are pivoted the front ends of piston-rods L and L', the rear ends of which are connected directly at c^3 and c^3 to the opposite arms c and c' of a rocking arm C, which is journaled in the frame B of the engine. A connecting-rod M, which is represented as pivoted at c^3 to the same pin which connects the piston-rod L' to the rocking arm, is connected to the crank-pin a, through the medium of which the main axle A is rotated. The upper and lower members $B\,b$ of the frame, which extend forward from the pedestal B', stop somewhat short of the cylinder-casting D, which is secured thereto by means of separate sections H and H' of the frame, the front ends of which are not shown. These sections are of cylindrical form for a whole or a portion of the part which engages the cylinder-casting and are adapted at the ends $h\,h^2$ to be secured to the frame $B\,b$, either by squaring the ends, as shown, to a cross-section, which is within the cross-section of the cylindrical portion, so that said sections of frame may be entered or withdrawn from cylindrical openings g and g', formed in the cylinder-casting D, or by a socket or other suitable connection, the cylindrical sections being firmly fitted in the openings g and g' in the cylinder-casting, so as to effectually prevent any movement on the frame-sections other than longitudinally without bolting the casting thereto, such longitudinal movement being prevented by end keys, as usual. By employing this means of attaching the cylinder to the frame, the inventor claims that he has secured economy in construction and avoided the use of bolts passing through the cylinder-casting and frame.

REAGAN'S COMPOUND LOCOMOTIVE.

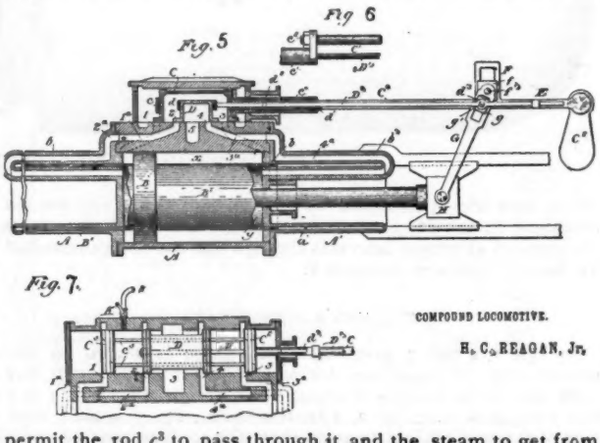
This somewhat peculiar construction is covered by patent No. 481,149, issued to H. C. Reagan, Jr., of Philadelphia. It is shown in fig. 5, a section of the cylinder; fig. 6, a detail; and fig. 7, a section of the steam-chest and valve of a different form from that in fig. 5.

Each cylinder A is provided with a piston B, which has on each side a cylindrical shell B', somewhat longer than the cylinder and less in diameter. These shells slide steam-tight in annular wells a, cored or otherwise formed in annular projections A', cast integral with or attached to the cylinder-heads. A packing-ring b is sprung into a groove near the outer end of each shell. The interior of the cylinder is thus divided into two concentric chambers x and y. The outer or annular chamber x is used as a high-pressure cylinder and the inner chamber y as a low-pressure cylinder, conducting the exhaust-steam from x into y, as hereinafter explained. To prevent too great transmission of heat from the chamber x to chamber y, the shells may be cast hollow and filled with asbestos b^3, in which case the shells are made separate from the piston and bolted thereto.

The valve-seat has two sets of admission-ports 1 3 2 4 and a single exhaust-port 5. The ports 1 3 lie farther from the exhaust-port and communicate by passages 1^a 3^a with the high-pressure chamber x. The ports 2 4 lie nearer the exhaust-port and communicate with the low-pressure chamber y by means of the passages 2^a 4^a, cored out in the valve-seat and in ribs b', which run out around the extensions B' and into the cylinder-heads. By conducting the high-pressure exhaust from passage 1^a into the opposite passage 4^a the desired compounding effect is reached. This may be done by any suitable valve or valves. The main valve C is arranged to open and close, the high-pressure ports 1 3 being given the proper lead and lap. It is actuated by a yoke c, to which is secured a sleeve c', which passes out through a stuffing-box at the back end of the steam-chest. An offset c^3 affords a point of attachment for the main valve-rod C', which is joined to the rocker-arm C^2 and is driven by the ordinary link and eccentrics. The low-pressure ports 2 4 and the exhaust-port 5 are never uncovered by this large main valve C. An auxiliary valve D is inclosed within the main valve C and opens and closes the ports 2 4, placing them alternately in connection with the interior of the main valve and with the exhaust-port 5. The valve D is actuated by a yoke d, attached to a rod D', which passes through a sleeve d', fastened to the valve C and lying concentrically within the sleeve c'. A packing-ring d^2 on the rod D' makes a tight joint between the rod and sleeve. The valves are free to move vertically in their yokes to allow for wear of the valve-seat, and the sleeve d' is smaller than the sleeve c', leaving an annular space to permit the valve C to settle downward as it wears on its seat.

By the operation of the main valve C the live steam is admitted alternately to the two ends of the chamber x, and the exhaust therefrom flows into the interior of the main valve.

The piston-valves shown in fig. 7 need no especial description, since their construction and operation are well understood. The pistons C^3 C^3 are joined by the rods c^3 and constitute the main valve C. The auxiliary valve D is hollow to



COMPOUND LOCOMOTIVE.

H. C. REAGAN, Jr.

permit the rod c^3 to pass through it and the steam to get from port 3 to port 2 and from port 1 to port 4, as explained above. A starting-valve K is placed in a pipe k, which leads from the boiler, so that live steam can be admitted to both sides of the high-pressure piston area and to one side of the low-pressure area simultaneously.

Manufactures.

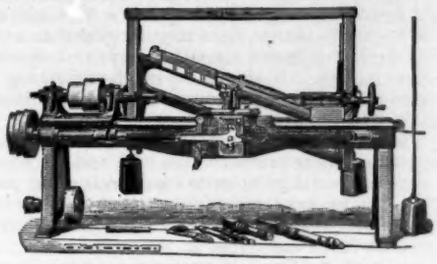
A New Automatic Gauge Lathe.

THE cut given herewith shows one instance of the advance made in wood-working tools intended to save time and labor. Heretofore large turning has been done on the ordinary wood lathe by hand, a slow method, and the tool shown has been devised to meet a demand for a lathe which will turn out such work automatically and with precision. This lathe is called by the makers No. 5, and will turn stock up to 6 in. in diameter and 42 in. long, a size heretofore considered impossible for an automatic lathe.

The bed is made in one solid piece, of extra width, planed perfectly true, with V's for the sliding rest to run back and

forth on, and a center bar on which is attached the form or pattern for roughing out the stock ready for the back knife to make the finishing cut. The top of the bed is also planed true, bringing the centers always exactly in line with each other.

The head-stock is furnished with journal-boxes of extra length lined with genuine babbitt metal, perfectly rigid to receive the large spindle, and on this spindle is a cone pulley with two speeds and an extra speed to drive the feed, connect-



NEW AUTOMATIC GAUGE LATHE.

ing a short countershaft below, which is part of the machine. Suitable provision is made for taking the thrust of the spindle.

The tail-stock is made on an improved plan and is provided with gears and screws so as to apply the power as near the center as it is possible to get, brnging same exactly in line with the driving center. This tail center revolves in a gun-metal taper sleeve box. Lost motion can be taken up from time to time so as to enable the operator to run a tight center. Provision is made to withstand the thrust of this center. Both the head and tail-stock are planed on the bottom so as to bring them exactly in line with each other.

The sliding carriage is made to move back and forth along the ways by a screw, operated by a cone pulley and from the feed-shaft below. Provision is made for opening and closing the nut automatically for moving the carriage back and forth. It is also fitted up with two adjustable arms, one for the roughing stock to fit the thimble-plate, and the others for roughing out the molded part of the stock, ready for the back knives to make their cut.

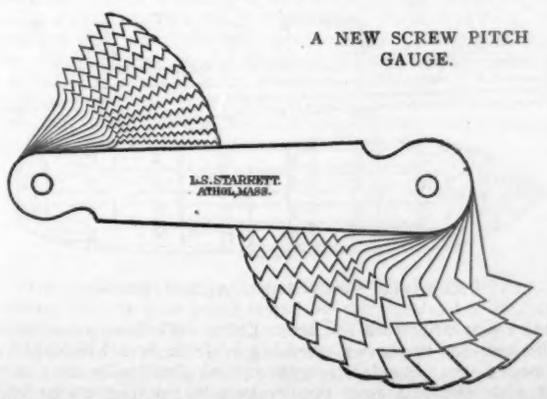
The back-knife attachment is connected to the bed, supported at the top and held perfectly rigid. The bar which carries the back knives is made to slide up and down in planed ways, countered by weights and controlled by the sliding rest. By this arrangement, the back knives are made to act on the stock close to the thimble-plate or support, thereby allowing the back knives to cut perfectly smooth and free. The back knives are attached to the bar and adjust on the frame and can be regulated to suit the different diameters to be turned.

There are three changes of feed furnished with the machine and two speeds to the cone to suit the different diameters of stock to be turned.

Further information can be obtained from the Egan Company, No. 194–214 West Front Street, Cincinnati, O., the builders and originators of this machine.

A New Screw-pitch Gauge.

THE accompanying illustration, which shows the gauge full size, represents a very handy gauge for measuring the pitches of screws. The teeth are sharp and clean cut, and it is a reli-



A NEW SCREW PITCH GAUGE.

able gauge by which to grind and test threading tools, at 60°. As will be seen, it is especially convenient for measuring inside threads.

The gauge shown is made to measure 24 different pitches: 4, 4½, 5, 5½, 6, 7, 8, 9, 10, 11, 11½, 12, 13, 14, 15, 16, 18, 20, 22, 24, 26, 27, 28, and 30. It is called No. 4 by the maker, Mr. L. S. Starrett, of Athol, Mass. Its convenience will be recognized by all machinists and foremen.

General Notes.

THE Akron Tool Company, Akron, O., recently made a large shipment of the McNeil balanced charging barrows for railroad work, is now making a large lot of special pattern for the United States Government. These barrows were recently adopted, after careful tests, by one of the oldest blast furnace companies in Pittsburgh.

THE Schenectady Locomotive Works recently completed for the Chicago & Alton Railroad six 10-wheel passenger engines with 19 × 24-in. cylinders and 70-in. drivers. The boilers are built for 170 lbs. working pressure.

THE Pittsburgh Locomotive Works are building 15 Mogul freight engines, with 19 × 26-in. cylinders, for the Duluth, Mesaba & Northern Railroad. These works recently completed for the Pittsburgh & Western a two-cylinder compound engine of the 10-wheel type, for freight service. This engine has cylinders 19 and 29 × 25 in. and 52-in. driving-wheels.

THE Baldwin Locomotive Works, in Philadelphia, recently built for the Atlantic Coast Line five locomotives for passenger service, having 68-in. driving-wheels. Three of them are simple engines and the other two are four-cylinder compound locomotives of the Vauclain type.

THE Youngstown Bridge Company, Youngstown, O., has taken a contract for a bridge over the Brazos River, near Sealey, Tex., on the new extension of the Missouri, Kansas & Texas Railroad.

THE Pacific Bridge Company, of San Francisco, has contract for the steel draw spans over the Nootsak River near Ferndale, Wash.

THE Baldwin Locomotive Works, in Philadelphia, are building a 10-wheel passenger engine of the Vauclain compound type for the Delaware, Lackawanna & Western Railroad. The cylinders are 13½ and 23 × 24 in. This will be the first compound locomotive on that road.

THE Brooks Locomotive Works, in Dunkirk, N. Y., are at work on an additional order for 25 freight engines for the Great Northern Railroad. They have recently completed a four-cylinder compound locomotive, with the cylinders placed in tandem, for that road. This engine will be tested on the Lake Shore road before it goes to the Great Northern.

THE Atlantic Coast Line is building 300 freight cars at its shops in Wilmington, N. C. Of these 225 will be ventilating cars for market traffic, and will be equipped with air brakes and M. C. B. standard couplers.

THE Jackson & Sharp Car Company, Wilmington, Del., are building six passenger cars for the Valley Railroad, of Ohio, and several passenger and baggage cars for the Atlantic Coast Line.

THE Madison Car Company, Madison, Ill., is building 500 box cars for the Wabash Railroad.

RECENT orders received by the Michigan-Peninsular Car Company, Detroit, Mich., include 600 box cars for the Lake Shore & Michigan Southern, and 1,000 box and coal cars for the Toledo & Ohio Central Railroad.

Steam-Heating Valve for Locomotives.

THE Consolidated Car-Heating Company has gotten up a special throttle valve to place on a locomotive for the purpose of controlling the connection by which steam is supplied to the train. This valve is made somewhat after the style of the valve furnished by the Westinghouse Air Brake Company for the purpose of controlling the admission of steam to the air brake pump. It, however, is made for 1-in. pipe instead of ¾ in. It has a connection for the dry-pipe, and is made very heavy and substantial.

This valve is also so designed that it can be placed in a horizontal position at the side of the boiler should there be lack of space on top of the boiler itself. It is so arranged that the dry-pipe connection may be made by the means of a bushing and entirely independent of the valve. This construction permits the throttle-valve to be placed directly on the boiler, or at any other convenient position in the steam pipe.

This valve is made of the best material, and is prepared to carry the highest steam pressures.

The Consolidated Company has also put upon the market a dust guard for the Sewall coupler, which is effective and simple. It is attached to the support chain of the Sewall coupler, and when the coupler is not in use it holds the coupler up and closes the end.

Svenson's Drawing Table.

THE accompanying illustrations show an exceedingly convenient drawing table devised by Mr. John Svenson, of Scranton, Pa., who has learned by long experience what would be most likely to serve the convenience of a draftsman and engineer.

The board, as will be seen from the engravings, is supported by a frame carried by pivots on the table; the weight of the board and frame is counterbalanced by a suspended weight, so that it can be easily moved to the required position. There are three of these which can be used; the board can be laid

Fig. 1.

Board horizontal.

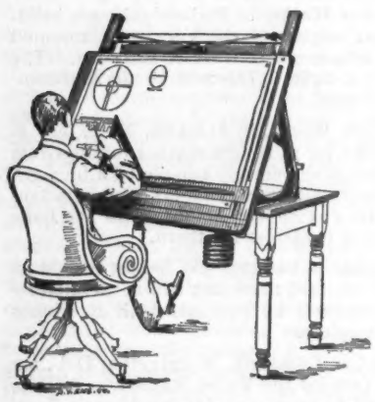


Fig. 2.

Board at an angle of 60°.

SVENSON'S DRAWING TABLE.

down in a horizontal position, as shown in fig. 1; it can be raised to an angle of 60°, where the draftsman prefers a sitting or standing position, as is shown in fig. 2; or it may be set at an angle of 45°, which is a convenient position when writing or lettering has to be done. At either the 60° or 45° angle the board can be raised or lowered over a range of about 3 ft. A fourth position may be mentioned, in which the board can be raised so as to clear the table altogether, permitting the latter to be used as an ordinary desk.

The ruler shown is a great addition to the convenience of the board. It moves easily, is accurate, and can be adjusted quickly. All the parts of the mechanism, except the straight edge, are out of sight, and protected from accidental injury. It carries a convenient shelf for instruments.

The ruler may be lifted from the paper far enough to pass it over a wet ink line, without disturbing the attachment to the cord. It is balanced in all angular positions of the board, requiring only a slight effort to move it, and retaining its position without holding.

Two styles are made by Mr. Svenson, the only difference being that in one case the base is a plain table with two drawers for instruments, and in the other it is a complete writing desk, with several drawers and a closet in the base.

Several months' use of this table in our own office has shown it to be a great improvement over the ordinary drawing table and board in every respect.

Gaskets for Boiler Manholes.

THE Hartford Steam Boiler Insurance Company's paper—the *Locomotive*—says: "The choice of a material for manhole gaskets cannot be too carefully made. The material should be yielding, elastic, tough, and these qualities should not be very much affected by the temperature of steam at ordinary pressures. It should be yielding, because this property enables it to adapt itself to any trifling inequalities of the seat or surface of the plate, thereby insuring a tight joint w th a minimum of trouble. It should be elastic, to enable the gasket to accommodate itself to slightly different sizes and shapes of manholes of the same nominal size. It should be tough and strong, as this is most important to prevent serious accident, and if it is affected but slightly by a temperature of, say, 350° F., a gasket may, if care be exercised, be used repeatedly, which is quite an important item when there are several boilers and the water is so bad as to necessitate frequent opening for cleaning purposes. Such gaskets can be procured without much trouble; but, to tell the truth, those lacking most, if not all, of the above desirable qualities are much more readily obtained."

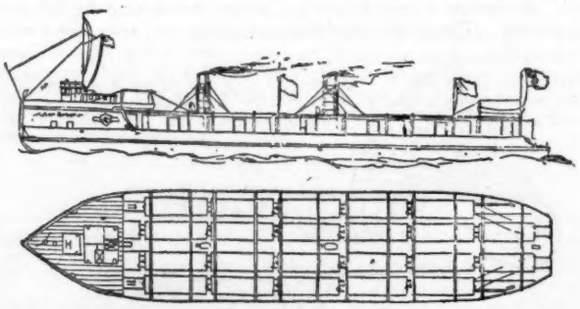
It is claimed that the Canfield pure molded gaskets, made in Bridgeport, Conn., fill the requirements which are well stated above. This claim seems to be supported by their extended use and the good service they have done.

Lake Ship-building.

THE Chicago Ship building Company at South Chicago has taken the contract for a new passenger steamer for the Lake Michigan & Lake Superior Transportation Company. This boat is to run between Chicago and Lake Superior ports. She will be of steel throughout, length over all, 295 ft.; keel, 275 ft.; beam, 42 ft.; depth to spar deck, 24½ ft.; depth to hurricane deck, 32 ft.; double water-bottom for ballast, 3½ ft. Seven water-tight bulkheads, one at each end of the ship, two in the freight hold, one at each end of the boilers, and one abaft the machinery. Engines of the triple-expansion type, diameter of cylinders 23, 38, and 62 by 36 in. stroke of piston, two double-ended Scotch type boilers 11½ ft. by 20 ft., and two masts. She will have accommodations for 400 passengers, and will be lighted by electricity throughout.

THE Craig Ship Yard at Toledo, O., recently launched *Ann Arbor No.* 1, the first of two ferry steamers built to carry cars across Lake Michigan from Frankfort, Mich., to Kewaunee, Wis., for the Toledo, Ann Arbor & Northern Railroad. The distance is 63 miles, the longest car-ferry in existence. The boat will carry 24 loaded freight cars at a trip. This ferry will have some peculiar difficulties, against which the construction of the boat is intended to guard. The accompanying sketch will give an idea of her general appearance. There are deep water and heavy seas, and in winter heavy running ice; consequently it was necessary to make the transfer boat with high and strong bows. The cars are loaded at the stern and the bow is decked for a distance of 50 ft. back and rises 25 ft. above the load-line. The vessel is 267 ft. long on deck, 52 ft. beam, and 18 ft. molded depth. It is calculated to draw 12 ft. of water, and to have a displacement of 2,550 tons at that draft.

The vessel is built of oak, with a solid frame up to 2 ft. above the loading line, and will have a belt of iron 6 ft. wide to pro-



TRANSFER BOAT "ANN ARBOR NO. 1."

tect the planking from the ice. Extra deck beams are placed at the load-line to prevent crushing in if the vessel is nipped in the heavy ice. She is strengthened longitudinally by a steel cord with diagonal steel ties every 4 ft. running to the keel. The keelson is strengthened with a steel plate 2 ft. wide and ⅝-in. thick. The vessel is so modeled as to ride over and crush down ice rather than cut it through.

There are twin screws in the stern and a single screw in the bow, which are worked by three horizontal compound condensing engines of 20 and 40-in. diameter and 36 in. stroke. There are three boilers 10 ft. in diameter and 14 ft. long, calculated for 125 lbs. of steam pressure. The vessel will be equipped with the latest appliances, such as steam steering gear, steam windlasses, electric lighting, and an electric search light to insure safety in night navigation.

The cars will be secured by a method different from any heretofore practiced. There are four tracks, and there will be two posts on each side of each car, between which posts the cars will be wedged by keys. These posts are connected longitudinally by heavy stringers, and diagonal tie-rods will be put in place between each two cars. These tie-rods will be provided with turn-buckles to properly adjust their length. By this arrangement any damage at any part of the structure will be largely localized. The cars will be held to the deck by four chains attached to the trucks, each with a turn-buckle. These attachments are also shown in the cross-section.

The vessel is expected to make a mean speed of 12 and a maximum speed of 15 miles per hour. The steamers are duplicates.

Beck's Steam Steering-Gear.

THE accompanying illustration shows the Beck steam steering-gear, which is now coming into extensive use in vessels built on the lakes. The general plan of the gear is shown in the engraving; it is a two-cylinder engine, the connecting-rods of which drive spur-wheels gearing into the main wheel which moves the rudder chains. The admission of steam to the cylinders is controlled by the hand-wheel entirely. The framing is well designed for the purpose, and the engine is compact in form, the largest size, which is suitable for a ship of 4,000 tons, occupying a floor space of only 27 × 48 in., while a size suitable for tugs and small vessels takes up only 18 × 36 in.

This engine may be placed in the pilot-house, below deck, in the engine-room, or aft, or it may be placed flat on deck and connected directly to the tiller, which arrangement will avoid the use of the usual long tiller ropes and sheaves which require constant attention. The No. 4 and 5 machines have been designed with special reference to being placed in the pilot-house and are always arranged for both steam and hand-steering. The change from steam to hand is made instantly, without loss of time or annoyance, which is very important when the boat is rolling heavily with the rudder adrift.

The engine will move as quickly or gradually as the hand-wheel is moved, and will stop automatically at the very instant that the hand-wheel stops. The exact position of the rudder is shown by an indicator at all times, whether steering by hand or steam, and when the run of the tiller chain is given, machines are fitted with automatic stop for hard-over positions of the rudder. Any overstrain on the rudder will cause the engine to open steam against the pistons to cushion the blow and fall back sufficiently to avoid accident or breakage, and the instant that the strain is off the engine will return the rudder to its former position, without any attention on the part of the pilot.

For all tugs and other vessels which require to be handled quickly, the wheel is arranged to put the rudder hard over by giving it a single turn; but in other cases where it is desirable to keep the steering-wheel movement uniform for both hand and steam, the machines are so arranged in order that no mistake can be made in steering when changing from one to the other.

This steering-gear is made by Pawling & Harnischfeger, of Milwaukee, Wis., and has met with general approval wherever it has been introduced.

The Jordan Train Signal.

A NEW electric train signal, invented by Mr. L. F. Jordan, of Portland, Me., is now being tested on the Portland & Rochester Railroad, thus far with success. The details have been very carefully worked out by the inventor, and the device is now in the hands of the Jordan Electric Train Signal Company.

This system, it is claimed, allows perfect communication between engineer and conductor, who may be on any part of the train, and when either signals to the other the message is automatically returned to the sender.

If the train breaks apart the engineer and conductor are notified at once as the parting of the coupler completes a circuit.

A battery is carried on each side of the engine. One is a reserve, and if the other gives out it can be put into use by simply turning a small lever in the cab.

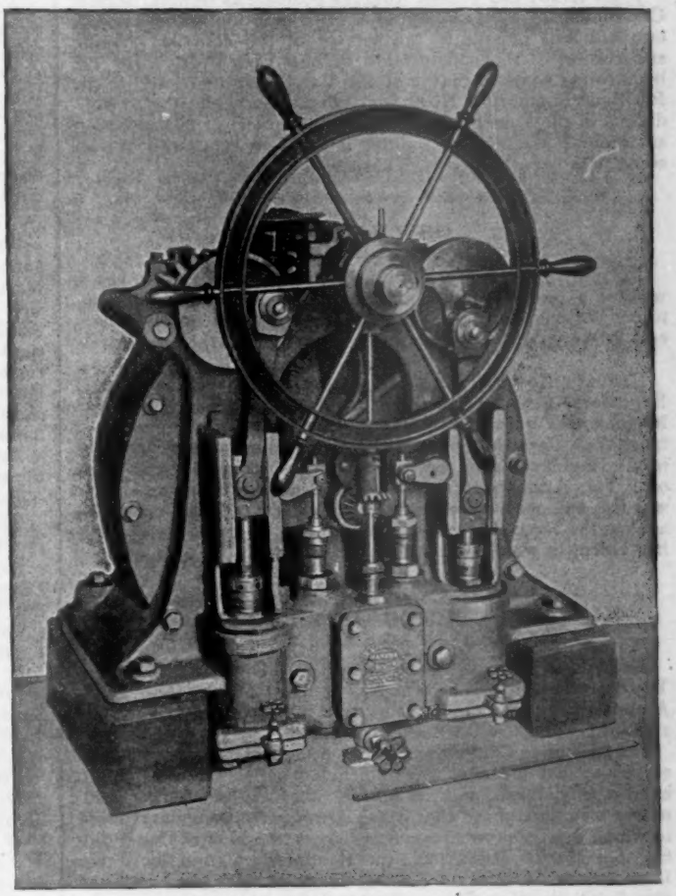
The engineer can test the entire system without disturbing any other part of the train. The batteries can be removed and replaced without any preliminary unfastening of wires, and are automatically put in circuit when placed in position. Therefore no skilled workmen are required to handle the system.

The engineer can alarm the baggage, express, and mail cars in case of robbery by touching a concealed button.

The batteries have been tested for two years, and the couplers have been in practical use for over two years. The tender is so wired that the water tank can be removed or new trucks put on without disturbing the wires.

The wires through the smoking and regular cars are enveloped in a green cord and suspended overhead in the place of the old bell-rope, and are so arranged that they cannot be broken by any ordinary carelessness.

The coupler is simple in construction, very durable, makes a sure connection every time, is fire and water-proof, of light weight, and is air-tight when closed. There is no chance of a short circuit by water, as the coupler is absolutely water-tight.



BECK'S STEAM STEERING GEAR.

PERSONALS.

JAMES RITCHIE has resigned his position as Assistant Chief Engineer of the Cleveland, Cincinnati, Chicago & St. Louis Railroad, and will engage in business in Cleveland, O.

COLONEL H. T. DOUGLAS, Chief Engineer of the Baltimore & Ohio, has resigned on account of continued ill health. W. T. MANNING, late Assistant, is now Acting Chief Engineer.

L. S. RANDOLPH has resigned as Engineer of Tests of the Baltimore & Ohio Railroad, to accept a position with the Baltimore Copper Company. His successor is B. F. HODGES, late of the Missouri Pacific.

B. F. CHADBOURNE, of Biddeford, has been appointed Railroad Commissioner of Maine. Mr. Chadbourne is an engineer, and has had much experience in railroad building in Maine, in Pennsylvania and in the South.

J. D. HAWKS has resigned his office as Chief Engineer of the Michigan Central Railroad, and has accepted the position of Manager of the Citizens' Street Railroad of Detroit. Mr. Hawks has had many years' experience as a railroad engineer, and has a high reputation.

C. M. BUCHHOLZ, Chief Engineer of the New York, Lake Erie & Western Railroad, has resigned that position, and has been chosen President of the Quaker City Elevated Railroad of Philadelphia. He will have charge of the building of that company's lines, the first of which is to run along Market Street. PROFESSOR LEWIS M. HAUPT is Consulting Engineer of the company.

JOHN KIRBY has retired from his position as General Master Car Builder of the Lake Shore & Michigan Southern Railroad, but will still remain in the service of the company, having supervision of the construction of new cars. Mr. Kirby has been for 34 years in charge of the Car Department, first of the Michigan Southern & Northern Indiana, and since the consolidation, of the Lake Shore & Michigan Southern. His successor as General Master Car Builder is A. M. WAITT, who has for some time been Mr. Kirby's assistant.

OBITUARIES.

JOHN M. SULLIVAN, who died in Richmond, Va., October 8, was for a number of years Master Mechanic of the Wilmington & Weldon Railroad, but for some years past has been General Foreman of the Richmond Locomotive & Machine Works.

CAPTAIN EDWARD MAGUIRE, of the United States Corps of Engineers, died in Philadelphia, Pa., October 10. Captain Maguire was born in Tennessee 46 years ago, and graduated from West Point in 1867. He held several prominent positions in the Engineer Corps, and several years ago published a book on "The Attack and Defense of Coast Fortifications." He was the engineer officer under General Terry in the campaign against the Sioux Indians succeeding that of the battle of Little Big Horn, in which General Custer was killed.

PROCEEDINGS OF SOCIETIES.

American Association of Railroad Superintendents.—The 21st meeting was held in New York, Monday, October 10. An amendment to the by-laws was adopted providing for a standard committee on Railroad Signals.

The Executive Committee presented a report on its proceedings since the last meeting which included action on the railroad exhibit at Chicago, and on several other matters. This Committee also announced that it had issued invitations in response to which delegates were presented from the Master Car-Builders', the Master Mechanics', the Roadmasters', and the Train Despatchers' Association. These delegates were presented and were cordially welcomed to the meeting.

A communication relating to the capacity of freight cars was referred to the Committee on Transportation, and a number of other communications were also referred to the proper committees, including one on the matter of a record of railroad employés.

The Secretary's report showed a total of 183 active, 10 associate, and 1 honorary member, representing 130 railroad lines. Applications for membership have been received from 55 persons representing 28 additional roads.

The Secretary presented a paper on Maintenance of Way, having special relation to the use of tie-plates on roads where the traffic is heavy. The Committee on Machinery presented a report on Compound Locomotives. This report was only a preliminary one, and suggested a number of points upon which further information was desired in order to make up a full report.

The Committee on Signals, through its Chairman, presented a long and interesting report, which did not receive full consideration owing to lack of time. In addition to this report, papers were presented of the Block System and on the Methods of Draw-bridge Protection.

The Committee on Transportation presented a report covering a brief catechism for railroad employés, and especially for trainmen. It was resolved that this catechism be presented to the Committee on Train Rules of the American Railroad Association, with the request that it be added to the present standard book of Train Rules.

Mr. Willard A. Smith, Chief of the Department of Transportation of the Columbian Exposition, made an interesting statement as to the character of the promised exhibit, which he said has exceeded all expectations.

The following officers were elected for the ensuing year: President, H. Stanley Goodwin; Vice-Presidents, G. W. Beach and C. H. Platt; Secretary, C. A. Hammond; Treasurer, R. W. Sully; Executive Committee, W. G. Watson and C. D. Hammond. It was decided to hold the spring meeting next year in Chicago, the time to be fixed by the Executive Committee.

In the evening the annual dinner of the Association was held, at which a number of members and invited guests were present.

American Society of Civil Engineers.—At the regular meeting on September 21 a discussion on Professor Merriman's paper on Roofing Slates, by Mr. C. B. Brush, was read. A paper on Tests of Power Required to Drive Electric Street Cars, by L. B. Bonnett, was read and briefly discussed, the importance of determining the loss of power in transmission being especially insisted upon. A third paper by Mr. Alfred F. Sears on Motive Power for Street Railroads was read and discussed, the advantages of steam motors, cables, and electricity being presented.

AT the regular meeting, October 5, a brief report of the delegates appointed to attend the International Congress on Internal Navigation at Paris was presented.

A paper on Combination Bridges on the Pacific Coast, by A. D. Ottewell, was read. He referred to the extensive use of combination bridges of wood and iron, which was chiefly due to the excellent quality of timber which could be obtained in that region. Several examples were sited, including the cantilever bridge across the Umpqua River in Oregon, which has a clear span of 290 ft.

Notes on Foundation Experiences, by Alfred P. Boller, was the second paper read. Both papers were briefly discussed.

THE following candidates were elected by the Board of Direction October 4.

Associates: Ludlow V. Clarke, Jr., Philadelphia, Pa.; Wilbur Chapman Fisk, New York City; Clifford Richardson, Washington, D. C.; Frederick Newton Willson, Princeton, N. J.

Juniors: Warren Rue Kinsey, Newark, N. J.; Morris Knowles, Montclair, N. J.; Reuben Miller, Jr., Pittsburgh, Pa.; Henry Lewis Oestreich, Jr., New York City; José Antonio Ruiloba y Dowling, Havana, Cuba; Francis Nicoll Sanders, Albany, N. Y.; Samuel Richards Thomas, Hokendanqua, Pa.; Elton David Walker, Chicago, Ill.; George Shreve Wilkins, Princeton, N. J.

The following candidates were elected by letter ballot:

Members: Charles Lee Crandall, Ithaca, N. Y.; William Lafayette Darling, Helena, Mont.; Augustus Jay Du Bois, New Haven, Conn.; Ignacio Garfias, Mexico, Mexico; Wallace Clyde Johnson, Niagara Falls, N. Y.; Harvey Linton, Altoona, Pa.; Lewis Abel Nichols, La Salle, Ill.; Joseph Hill Paddock, Connellsville, Pa.; Charles Herbert Wright, Wilmington, Del.

Associate Members: Robert Campbell Gemmel, Pendleton, Ore.; Francis Asbury Lyte, Kane, Pa.; Sidney Austin Parsons, Everett, Wash.; George Warner Sherwood, Riverside, Cal.; Jonas Waldo Smith, Montclair, N. J.; William de Hertburne Washington, New York City.

Engineers' Club of Philadelphia.—At the regular meeting of October 1, the tellers reported the election of the following gentlemen to active membership: Pierre Giron, William L. Austin, J. S. Robeson, George H. Paine, Daniel W. Pedrick, Charles S. Schwarz, W. G. Coughlin, Paul L. Wolfel, William C. H. Slagle, George F. D. Trask and Silas G. Comfort.

The resignation of Mr. Edwin S. Cramp was presented and accepted.

Mr. John C. Trautwine, Jr., was appointed to serve as the Club's representative to aid the Committee of the American Society of Civil Engineers, by the suggestion of suitable persons to furnish papers for the meeting of the World's Congress Auxiliary of the Chicago Exposition.

Mr. Strickland L. Kneass read a paper on the History and Development of the Injector, giving a detailed description of the Giffard injector, as originally constructed, and the improvements devised to overcome the objections urged against it. The self-regulating principle, as embodied in the movable com-

bining tube and the double jet injector, was explained, and interesting statements were given regarding the extended use of the injector as a boiler feeder at the present day. Mr. Kneass' paper was illustrated by a large collection of handsome working models, showing the development of the injector from the earliest invention to the best types now in use, and also by blackboard sketches.

Mr. Carl G. Barth gave an interesting blackboard discussion of the Distribution of Pressure in Bearings, maintaining that the center of pressure in an ordinary step bearing should be taken at one-half the radius, instead of two-thirds, as is usual. After considering a number of theoretical questions relating to cylindrical bearings, Mr. Barth gave some practical suggestions regarding their application to machine construction, and concluded by showing the advantage of placing and proportioning all bearings according to the principles demonstrated.

His results were discussed at some length by Messrs. Christie, Wilfred Lewis and others.

Boston Society of Civil Engineers.—The first meeting of the season was held in Boston, September 21. Joseph N. Drew, of Malden, Mass., was chosen a member. The President announced the death of Mr. James B. Francis, the oldest member of the Society, and a committee was appointed to prepare an appropriate memorial.

Mr. A.W. Locke read a paper on the Gradual Abolition of Highway Grade Crossings, and had lantern views exhibited showing grade crossings, gates and bridge structures, etc., here and abroad. A discussion followed in which J. W. Ellis, A. F. Noyes, F. H. Snow, Fred Brooks, G. A. Kimball and others participated.

Engineers' Society of Western Pennsylvania.—At the regular monthly meeting in Pittsburgh, September 20, resolutions in regard to the death of William Thaw, Jr., were adopted. It was announced that the Society's quota for the fund for the Engineering Congress at the Columbian Exposition had been raised.

Mr. Gustav Kaufman read a paper on the Reconstruction of the Ninth Street Bridge in Pittsburgh, giving some interesting details. This paper was discussed by a number of members present. In the course of the discussion reference was made to the old tubular bridge at Brownville, Pa., which was built in 1822, and is believed to be the first tubular bridge built in the United States.

THE regular meeting of the Chemical Section was held in Pittsburgh, September 27. Dr. Charles B. Dudley delivered an address on Causes of Discrepancy in Chemical Analysis. He thought there were four possible causes.

1. Non-uniformity of Samples. This trouble could be discovered by exchange of samples.

2. Impure Chemicals. Chemists in cases of dispute should exchange samples and chemicals both.

3. Poor Manipulation. This can generally be discovered if the two chemists work together.

4. Faulty or Varying Methods. The adoption of uniform methods would be very desirable. He quoted from a well-known professor who used to say: "No chemist has ever made an *accurate* analysis. Some chemists can *work close enough to accuracy*, so that their work is valuable."

Western Society of Engineers.—At the regular meeting, September 27, a number of Committee reports were presented and acted upon after discussion. A letter from the American Society of Civil Engineers was read asking for assistance in the work of obtaining papers for the Engineering Congress next year. No papers were read, the meeting being held to dispatch accumulated business.

Civil Engineers' Society of St. Paul.—At the regular meeting of October 3 some routine business was transacted. Messrs. William R. Mansel, John S. Beeston, and Charles A. Hunt were elected members of the Club.

Engineers' Club of St. Louis.—The first meeting of the season was held in St. Louis, September 21. The question of changing quarters and securing permanent accommodations was made the regular order for the next meeting.

Professor W. B. Potter then read a paper on Water Supply for Large Cities, showing how the supply was affected by the water shed and describing in detail the nature and character of the impurities found in rain, surface, ground and deep water. A number of tables were exhibited showing the sources of the water supplies of the larger cities of the country.

Discussion followed by Messrs. Flad, Johnson, Seddon, Potter, Wheeler, Crosby and Russell.

AT the regular meeting of October 5 the question of new quarters for the Club was generally discussed, without final action. An amendment to the by-laws was submitted.

Mr. Ockerson exhibited a series of blue prints showing the changes in the Mississippi River channel for the last 12 years.

Mr. Melcher exhibited a number of blue prints and photographs of the Lidgerwood machinery.

Civil Engineers' Club of Cleveland.—The September meeting of the Club was held in the club rooms, September 13. Willard Fuller was elected an active member.

Professor C. H. Benjamin, of Case School of Applied Science, read a paper on Some Experiments on the Effect of Punching on Soft Steel. The experiments described were made at the mechanical laboratory of Case School of Applied Science.

Central Railroad Club.—A meeting was held in Buffalo, September 28, at which a report was received from the Committee appointed to confer with the Superintendents' Association concerning the delivery of cars consigned to local points which are in bad order, but not unsafe to run. After considerable discussion the Club voted to notify the Superintendents' Association, that in its opinion cars for local points bearing M. C. B. defect cards should be accepted if not unsafe to run to their destination, provided they bear an additional card directing their return empty.

Western Railroad Club.—The annual meeting was held in Chicago, September 20, when the reports of the officers were presented and the following officers were chosen for the ensuing year: President, W. H. Lewis; Vice-Presidents, A. M. Waitt and William Forsyth; Treasurer, Allen Cooke; Secretary, Waldo H Marshall.

After the adjournment the Club accepted an invitation to visit the buildings of the Columbian Exposition.

Northwest Railroad Club.—The first meeting of the season was held in St. Paul, Minn. September 13. Mr. J. C. Halladay read a paper on the subject of Car Heating by Steam, which was illustrated by the models of the Consolidated Car Heating Company's apparatus. This was followed by some discussion.

Roadmasters' Association of America.—The Secretary announces that the dates upon which the next convention of this Association will be held have been changed to November 15, 16 and 17, on account of the large number of members of the Association who are employed on roads centering in Chicago, and who, owing to the immense traffic over their lines before and after the Columbian Exposition opening ceremonies, cannot leave their posts of duty.

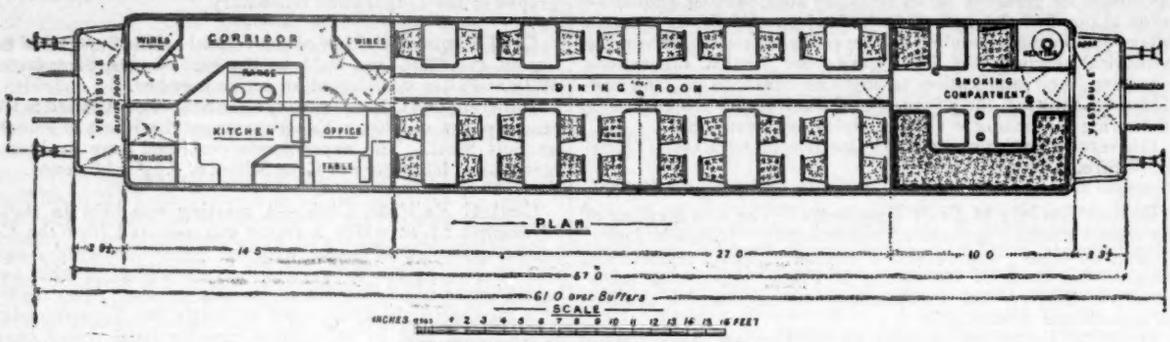
The convention will accordingly meet in Chattanooga, Tenn., November 15, and will adjourn to Atlanta, Ga., on the following day.

NOTES AND NEWS.

European Dining Cars.—The diagram herewith, from the London *Engineer*, gives a plan of one of several dining cars recently built by Brown, Marshalls & Company, at Birmingham, England, for the Compagnie Internationale des Wagons-Lits et des Grands Express Européens of Paris. They are intended to run in connection with the Indian mail train from Calais to Brindisi, meeting the Peninsula and Oriental steamers. The carriages are 61 ft. long and 9 ft. 2 in. wide. The dining-room in each car is arranged to seat 30 persons at 10 tables, five of which are for four persons each, and the other five to accommodate two persons each. At one end of the dining-room a swing door opens into a luxurious smoking-room furnished with sofa and easy-chairs to accommodate seven passengers.

The partition between the dining and smoking-rooms has panels of beveled glass; the other ends of the dining-room and smoking-room are ornamented with beveled mirrors. The partitions and side walls are of polished teak, with fielded panels and moldings. The tables are of light oak covered with linoleum, the ceilings being of figured oak in three thicknesses elaborately hand-painted with arabesque ornament, fruit and game, and bordered with ornamental teak moldings. The roof is of the "monitor" shape, fitted with windows glazed with colored glass, opened by means of handles to allow of ample ventilation, and protected on the outside by fine copper wire gauze. The saloons are lighted by gas chandeliers. The windows

open at the top and slide in brass grooves, the frames being edged with velvet to prevent any rattle, and strips of India-rubber are placed over all joints to exclude drafts. The windows are all provided with spring roller blinds. The floor, which is of white pine, is covered first with a thick layer of felt, then with linoleum, and on this is laid a Wilton pile carpet, and along the gangway between the tables is a narrow carpet of hair and worsted. Electric bells are fitted, each table having communication with the pantry. At the opposite end of the dining-room there is a swing door opening into a long corridor, off which are the compartments for the servants—namely, the pantry, kitchen, wine cupboards, etc. The pantry has double doors, and is provided with tables, cupboard, shelves for glasses, ice-boxes, and wash-basin. The two wine cupboards open off the corridor, and are fitted with refrigerators, and have ample room to carry enough wine for the double journey. The kitchen has a sliding door opening from the vestibule at the end of the corridor; at the side of the door is a large cupboard fitted up with shelves; in this cupboard a refrigerator is fixed. The kitchen is furnished with a cooking range, copper, hot and cold water tanks, sinks for hot and cold water, pump for filling the tanks, and all the necessary hooks for kitchen utensils. The kitchen is lined throughout with sheet iron, interlined with asbestos sheets to make the whole fireproof. The carriages are heated throughout with hot-water apparatus, and the furnace is accessible from the vestibule at the smoking-room end; the pipes are of copper, and run along the sides of carriages under the tables. At each end of the carriage there is a covered vestibule, with a door at each side opening on to the steps. The carriage is built on a composite wood and steel underframe, the outside longitudinal timbers being strengthened by Siemens-Martin steel channels in one piece the whole length, and bent at each end to the shape of the covered platform. Each carriage is mounted on two four-wheeled bogies made of iron with oak bolsters. The wheels are the Arbel solid pressed pattern with crucible steel tires. The carriages are fitted with the Westinghouse automatic brake; the vacuum and Smith-Hardy brakes are also provided on the carriages, so that they can be worked over the various railroads on the Continent. The saloons are built to the designs of M. Felix Gain, Engineer of the Compagnie Internationale.



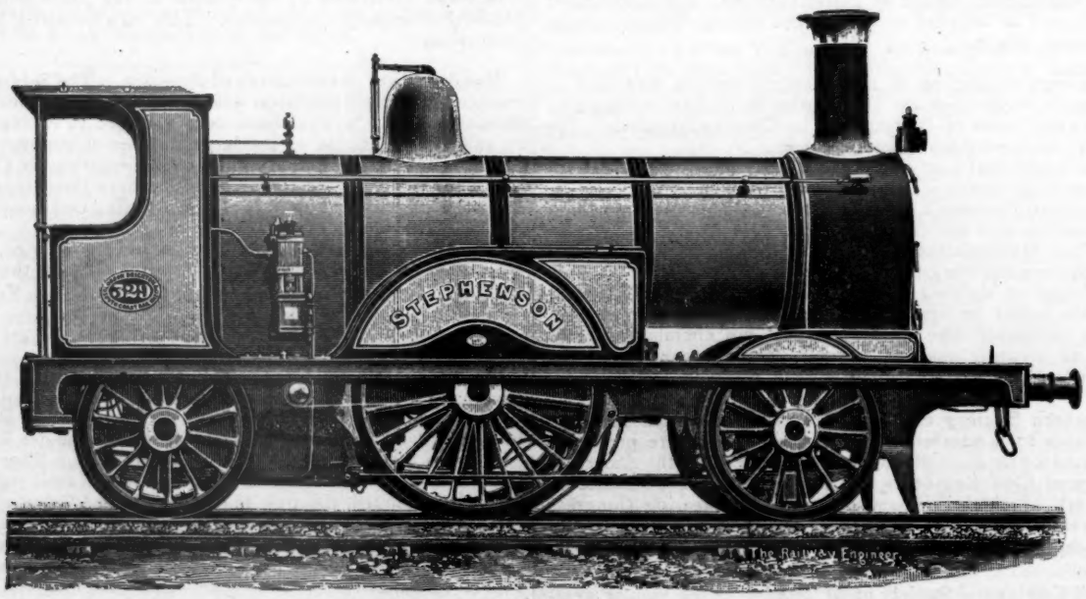
GENERAL PLAN OF EXPRERR DINING CAR

An English Express Locomotive.—The accompanying illustration, from the *Railway Engineer*, shows the standard express engine of the London, Brighton & South Coast Railway. In this engine, designed by the late Mr. William Stroudley, the older style of English construction has been closely adhered to.

The engine is carried on six wheels, having a single pair of drivers. The leading and trailing wheels are 54 in. and the driving wheels, 78 in. in diameter. The cylinders, which are 17 in. in diameter and 24 in. stroke, are placed inside. The steam ports are 15 × 1½ in. and the exhaust ports 15 × 2½ in. The valves have 3¾ in. maximum travel, ⅞ in. outside lap and ¼ in. inside lap. The valve motion is the ordinary shifting link.

The boiler is 51 in. in diameter, and has 262 tubes 1½ in. in diameter and 10 ft. 6 in. long. The fire-box is of copper. The grate area is 17 sq. ft., and the heating surface is: Fire-box, 100; tubes, 1,084; total, 1,184 sq. ft.

The total weight of the engine is 74,800 lbs., of which 30,250 lbs. are carried on the driving-wheels. The total wheel-base is 15 ft. 11 in. The tender is carried on six wheels, and has a capacity of 2,250 galls. of water and 2 tons of coal. It is stated that the average train hauled by engines of this class is about 110 tons, and that the average coal consumption is about 29 lbs. per train mile.



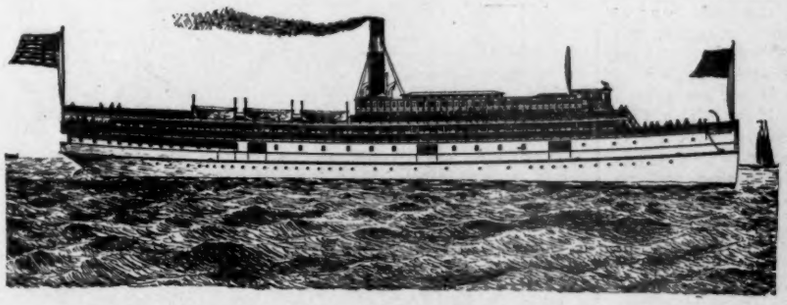
EXPRESS LOCOMOTIVE FOR THE LONDON, BRIGHTON AND SOUTH COAST RAILWAY.

Engines of a Modern Battle-Ship.—In our last issue we commented upon the "voluminous" outfit of a modern war vessel, and since then applied to Mr. George W. Dickie, manager of the Union Iron Works in this city, for particulars respecting the number of steam-engines on the battle-ship *Oregon*. Mr. Dickie has sent the following list, set down from memory, which is here arranged in tabular form:

Number of Engine Cylinders.	Purpose of Engines.	Characters of Engines.	Diameter of Cylinders in Inches.	Stroke in Inches.
6.....	Main Driving, 9,000 H. P.....	Triple.....	34½", 48", 75"	42"
4.....	For Air Pumps.....	Double.....	6"	12"
4.....	For Circulating Pumps.....	Compound.	7", 12"	6"
2.....	Hot Well Pump Engines.....	Single.....	8"	16"
2.....	Fire and Bilge-Pump Engines.	Single.....	10"	16"
2.....	Air and Circulating Pumps....	Single.....	10"	16"
4.....	Ventilating Fans.....	Compound.	5", 9"	6"
4.....	Barring Engines.....	Double.....	6"	6"
2.....	Reversing Engines.....	Single.....	14"	18"
4.....	Hydraulic Steering Gears.....	Double ...	8"	12"
4.....	Main Feed Pumps.....	Single.....	12"	16"
4.....	Auxiliary Feed Pumps.....	Single.....	10"	16"
8.....	Ash Hoisting.....	Single.....	5"	6"
16.....	Fire-Room Fans.....	Compound.	5", 9"	6"
4.....	Steam Cranes.....	Double.....	8"	10"
12.....	Hydraulic Pumping.....	Single.....	20"	30"
8.....	Steam Winches.....	Double.....	8"	10"
2.....	Windlass Engines.....	Double.....	16"	12"
8.....	Dynamo Engines.....	Compound.	7", 12"	6"
2.....	Ice Machines.....	Double.....	12"	16"
8.....	Ventilation.....	Compound.	5", 9"	6"
1.....	Distilling Room, Air.....	Single.....	10"	12"
1.....	Water and Brine.....	Single.....	6"	10"

Besides this list, making 112 engines, counting each steam cylinder, there are some connected with the torpedo service, the dimensions of which are not yet determined. After looking over this list one will conclude that the steam machinery of a modern war-ship is the principal part. She is indeed a great magazine of machinery, much of it of a delicate nature, and all requiring intelligent care.—*Industry, San Francisco.*

Rebuilding a Pittsburgh Bridge.—At a recent meeting of the Engineers' Society of Western Pennsylvania Mr. Gustave Kaufman read an interesting paper on the Reconstruction of the Ninth Street Bridge in Pittsburgh. This bridge, finished in 1840, was originally of the Burr type of combined arches and trusses, of one span of 190 ft. and four spans of 200 ft. in the clear. The piers were 9 ft. wide on top and 35 ft. long; they had semicircular ends, thus making the total length of the piers 44 ft. The foundations of all masonry in the river were timber platforms. The price paid for the masonry was about $7 per cubic yard. The substructure cost about $37,000, and the superstructure about $33,000; with approaches the bridge cost about $80,000. The bridge was covered on all sides and top, and offered great resistance to the wind. In 1889 this bridge, which was still in a safe condition for slow traffic, fell into the control of the Pleasant Valley Electric Street Railroad Company, which at once began to replace the old structure with one that would be adapted to rapid-transit traffic purposes. The requirements of the Company were:



PROPELLER "ALABAMA," CHESAPEAKE BAY.

1. The new structure to be wide enough for four lines, two for quick rapid transit and two for slow transit; and for two sidewalks of 10 ft.

2. The old masonry to be used.

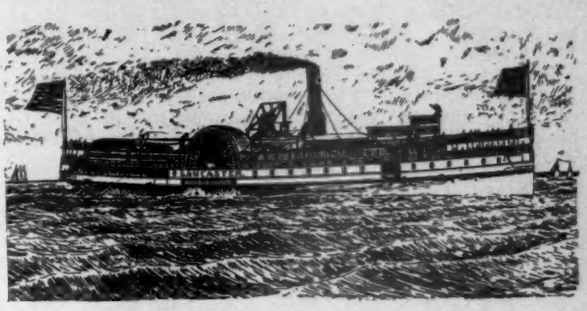
3. The old structure to be removed and traffic maintained during the erection of the new bridge.

4. The structure to be designed on strictly economical principles, and no ornaments to be used, the substructure to consist of five spans of plain Pratt trusses.

5. The load on the floor to be 12 tons on two pairs of wheels 10 ft. apart, or a uniform load of 100 lbs. per square foot. The trusses to be figured to carry a moving load of 4,000 lbs. per linear foot.

The work necessitated the building of a new abutment on the Pittsburgh side, the rebuilding of the tops of all the piers, a new pier on the Allegheny side, and an entirely new superstructure, the trusses of which are of steel, and the entire new floor and lateral system of iron. The paper describes in detail the work as performed, including the strengthening of the masonry on the old piers by the inflow of hydraulic cement; the cutting down and rebuilding the tops of the piers; the removing of the skew-backs and the building up of the piers to a uniform section between the new trusses; the raising of the bridge spans to meet the requirements of the U. S. Government Engineers.

The work was completed in the fall of 1890 without injury to any person and practically without cessation of traffic.



SIDE-WHEEL STEAMBOAT "LANCASTER," CHESAPEAKE BAY.

Two Chesapeake Bay Steamboats.—The two illustrations given on this page, which we take from *Seaboard*, show two different and contrasting styles of steamboats, both recently built in the new Sparrow's Point ship-yard, Baltimore, for service on Chesapeake Bay. Both are intended for freight and passenger service, and both have large freight capacity and handsome passenger accommodations.

The first is the *Lancaster*, a side-wheel steel boat built for the Weems Line, between Baltimore and Fredericksburg. On part of this route, up the Rappahannock River, the depth of water is not great, and a light draft boat is needed. The *Lancaster* is 213 ft. long over all, 32 ft. molded beam, 12 ft. depth and 57 ft. wide over the guards. She is propelled by paddle-wheels 30 ft. in diameter and 8 ft. face, driven by a beam engine with cylinder 48 in. in diameter and 11 ft. stroke. The valve gear is of the toe-and-lifter type commonly used with beam engines, but an adaptation of the Hackworth valve gear is used to give an adjustable cut-off. The wheel frames are of iron with cast-steel centers, and the gallows-frame carrying the walking-beam is built up of steel plates and angles. There is a surface condenser with an independent centrifugal circulating pump. There are two Scotch boilers 10 ft. 9 in. in diameter and 15 ft. 6 in. long, working at 50 lbs. pressure; each boiler has three 39-in. furnaces, the total grate area being 217 sq. ft.

The second boat is the *Alabama*, just launched, and built for the Bay Line between Baltimore and Norfolk. She is of steel and is 305 ft. long over all, 18 ft. 1 in. molded depth, 43 ft. beam and 55 ft. wide over the guards. The frames and outside plating are unusually heavy. She is propelled by a single screw 12 ft. 9 in. in diameter, built up with steel blades. This is driven by a vertical triple-expansion engine having high-pressure cylinder 24½ in., intermediate 40 in., and two low-pressure cylinders each 47 in., all being 42 in. stroke. The high-pressure cylinder has piston valves, the others slide valves. The condenser has an independent centrifugal circulating pump; the air pump is worked from the main engine. There are four boilers, each 12 ft. 9 in. in diameter and 10 ft. 8 in. long, with three 44-in. furnaces. The total grate area is 264 sq. ft. The usual working pressure is 160 lbs.

Both of these boats have electric light plants, are lighted throughout by electricity and provided with powerful search-lights. Both have steam reversing and turning gear for their engines.

Locomotives in England.—According to figures compiled by Mr. Clement E. Stretton from official returns, there are in service on the railroads of England and Wales 14,314 locomo-

tives; Scotland, 1,841; Ireland, 705; making a total of 16,860 locomotives.

The London & Northwestern Company stands first in the list, having 2,648 locomotives, and the Midland comes next, with 2,020. Three other companies have over 1,000 each, the Great Western reporting 1,660, the Northeastern 1,560, and the Lancashire & Yorkshire 1,127.

The Caledonian Company has the greatest number of any of the Scotch lines, owning 690 engines. The Great Southern & Western leads the Irish companies, having 178.

In the United States, according to *Poor's Manual*, there are 33,563 locomotives. By last reports the Pennsylvania Railroad had 1,623 and the New York Central & Hudson River 1,123 locomotives. These numbers have doubtless increased somewhat since the close of last year.

A Steam Bell-Ringer.—In the JOURNAL for April, 1887, there was published a description of a steam bell-ringer invent-

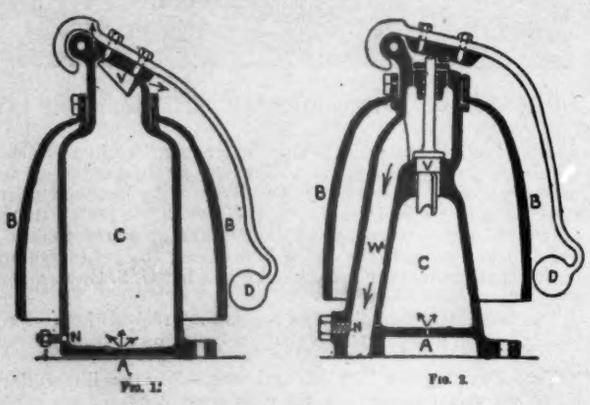


FIG. 1. FIG. 2.

LATOWSKI'S STEAM BELL-RINGER.

ed by Herr Latowski, of Munich, Germany. This device has since been somewhat modified and is now coming into extensive use in Germany. The illustrations given herewith and the description of the present form are from the *Practical Engineer*.

In the device illustrated, an effective operation of the bell is secured in an automatic manner by merely opening a steam tap, just as in the case of a whistle. The mode of action, which is as simple as it is ingenious, will be readily seen on reference to the sketch, fig. 1, and, like one or two other inventions in connection with the use of steam, is stated to have been suggested by the behavior of a common steam kettle, the loosely fitting lid of which may sometimes be observed to chatter on its seat as the steam generated within escapes in a series of puffs. The bell *B B* is arranged in the form of a cap, surmounting the chamber *C*, to which steam is admitted by means of a stop cock, through a very small opening in the bottom, at the point *A*. The top of the chamber, it will be observed, is closed with a valve, *V*, of lever construction, the loaded end *D* of which constitutes the bell clapper. It will be manifest that as soon as the steam pressure within the chamber *C* overcomes the load, the valve *V* is lifted from its seat, and as this is of considerable area the pressure is at once relieved, and it falls back again, causing the clapper *D* to strike a blow. The closing of the valve is, of course, quickly followed by another rise of pressure, when the operation is again repeated and another blow is struck, and so on in rapid rhythmic succession, so long as the tap communicating with the chamber *C* through the small hole at *A* is left open. The ringing of the bell is accompanied by a slight escape of steam in a series of puffs from the valve *V*. At *N* is a small hole fitted with a plug, to permit of the escape of any condensated water within the chamber *C*.

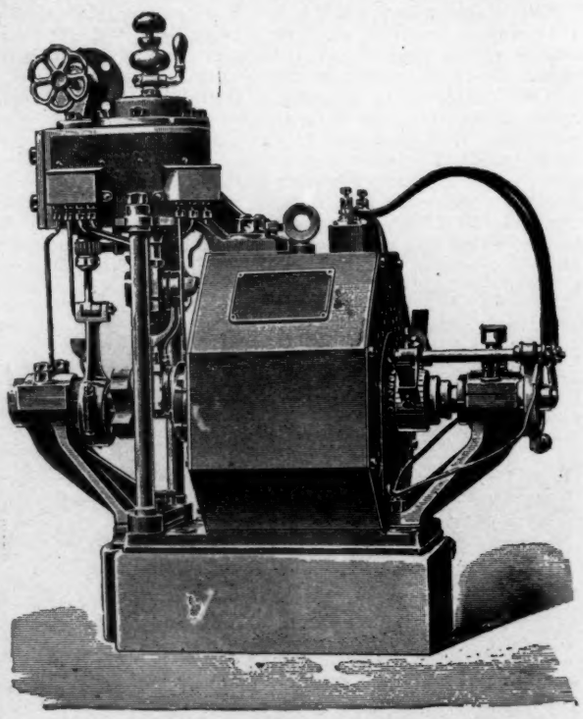
Fig. 2 shows another arrangement of the device, in which the lifting of the clapper *D* is effected through the medium of a common mushroom valve, *V*, fitted with a spindle passing through a freely fitting stuffing-box, which prevents any escape of steam from the bell interfering in any way with the outlook of the driver, the steam, instead of escaping in a series of puffs, being led away by means of the discharge-pipe *W* to the smoke-stack.

Iron Turnings in Foundation.—A very simple method of laying the foundations on a swampy location, which did not furnish a firm sub-soil, was employed, says the *Great Divide*, by an American engineer for supporting a low wooden building to be used for storage of machinery. Casks were set in holes in the ground along the line of posts, and were filled to the depth of about one foot with iron turnings. The posts were set in casks, which were then filled with iron turnings compactly rammed in place. A solution of salt and water was then slowly poured over these turnings, which compactly solidified into a hard mass. The heat of the oxidation of the iron was so great that the posts smoked and were charred, the latter fact probably being the reason why they have not as yet exhibited any signs of decay, and in this respect the use of iron turnings furnishes an advantage over the use of concrete for cask foundations.

Iron Roads.—An engineer writes to the Pittsburgh *Dispatch*, referring to the great cost of making stone or gravel roads in many places, claiming also that in many parts of the country the stone road would be impossible, as the hauling of the stone to it would wear out more than the load would make. In fact, he thinks there is not enough of available road-making stone in the United States to accomplish the task. Aside from this, he believes that the stone road is behind the age. Superior as it is to the common dirt road, it is almost as far behind the iron track as the dirt road is behind it. He says the railroad, street car track and the tramway all point the way of the future road. The track for the wheel must be of iron. It is the only material that is unyielding to the wheel, and smooth. He advocates the laying of iron beams from 6 to 8 in. wide slightly concaved. He says it can be done for one-third the cost of macadamized road, and, even without providing any better footing for the horse than now exists, it will work a revelation in traffic.

The idea is not a new one by any means, but might be available where iron is to be had at a low rate and stone is not accessible.

A Small Steam Dynamo.—The usual practice in designing a direct-driven dynamo is to take an ordinary engine and an ordinary dynamo and to couple them together. This produces a rather clumsy result. More recently the engine has been made with a prolonged or altered bed-plate, so that the dynamo can be mounted on it. The dynamo thus becomes a sort of attachment to the engine. In the steam dynamo, which we illustrate, the reverse practice has been followed—the engine is a mere attachment to the dynamo. It will be observed that the dynamo has its bed-plate carried out a few inches further than usual, and the bearing bracket projects out. The thrust of the



COMBINED DYNAMO AND ENGINE.

engine is taken by two light wrought-iron pillars, and the cylinder is cast with a bracket, which is bolted to the field magnets. The floor space required is no larger than if the dynamo had a pulley for belt driving. The little engine is specially designed to be suitable for ship lighting. The dynamo itself presents no remarkable features, being a four-pole machine of a type that is very common in Germany. The maker is Herr Gustav Conz, of 45a, Spaldingstrasse, Hamburg.—*Industries*.